AUGUST 1956

THE WELDING JOURNAL

IN THIS ISSUE

Ultrasonic Welding 761
Welded Overlay Rotating Bands 767
Electrodes for Arc Welding Austenitic Manganese Steels 776
Automatic Hard Surfacing Saves Pipe and Catalyst 784
Metal-Powder Electrodes and Their Applications 791
Economics of Welding Small Noncritical Pipe 796
Aluminum Additions to Mild-Steel Weld Metal 361-s
Influence of Oxygen on Molybdenum Welds 369-s
Embrittlement of Ship Steel in Nitrate Salt Bath 383-s
Stress-Corrosion Cracking of Stainless Steel 389-s
Arc Welding Temperatures 396-s
Welding of Cupro-Nickels by Inert-Arc Processes 401-s
Table of Contents 757
Editorial 759
Index to Advertisers 856

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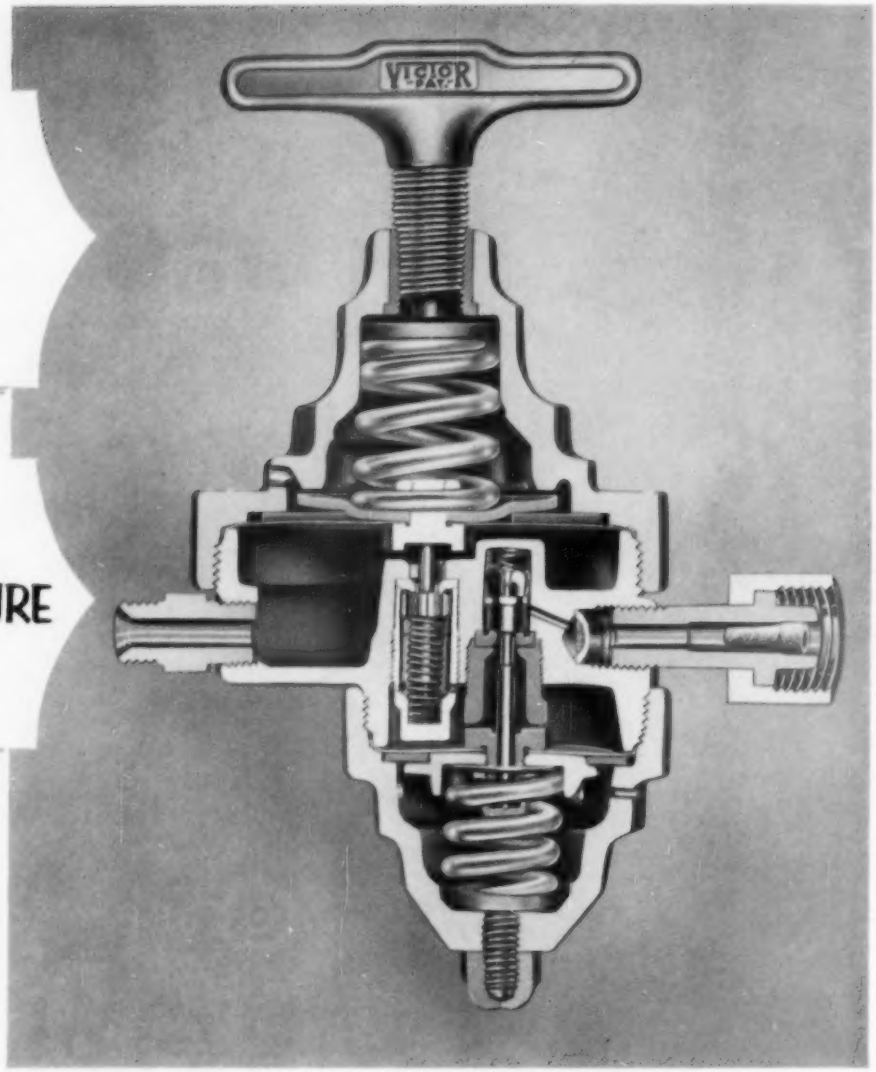

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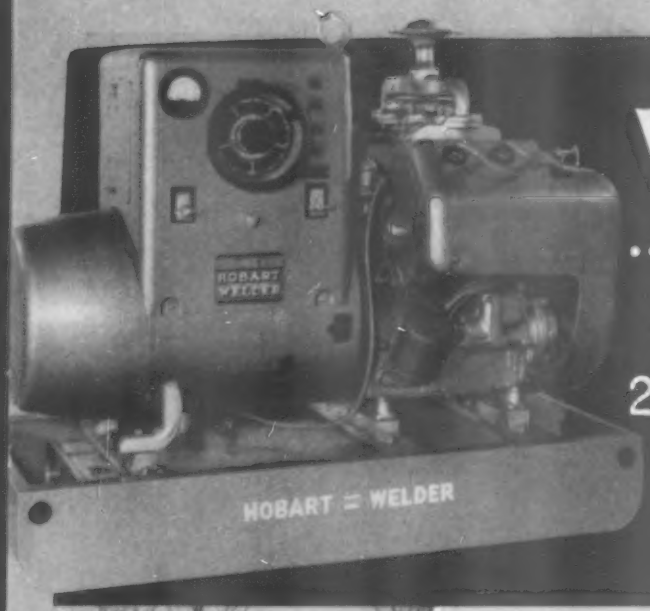

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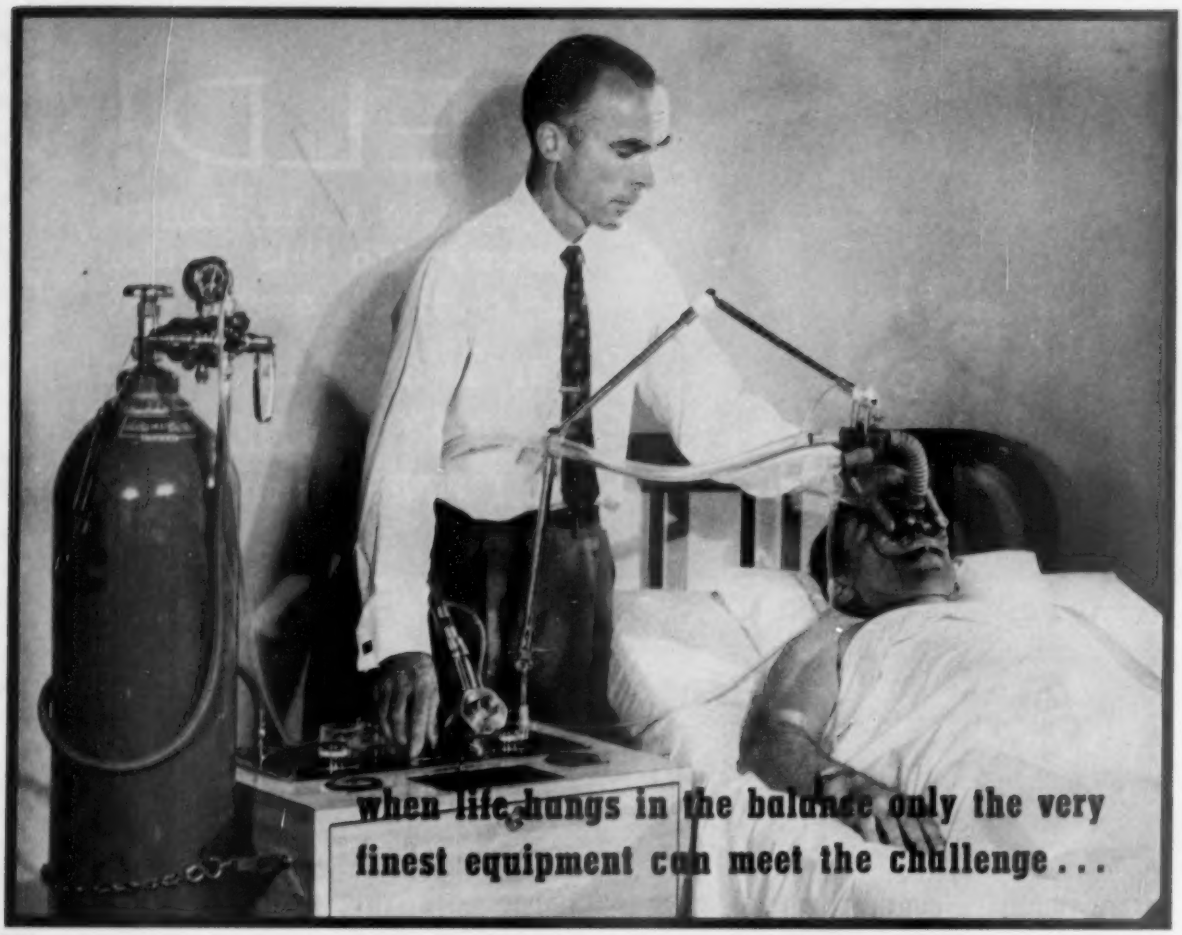

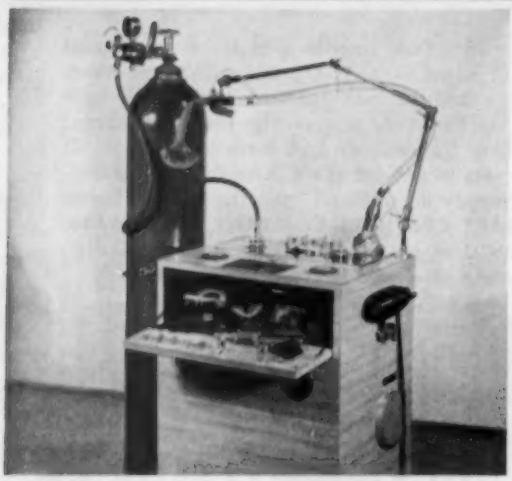

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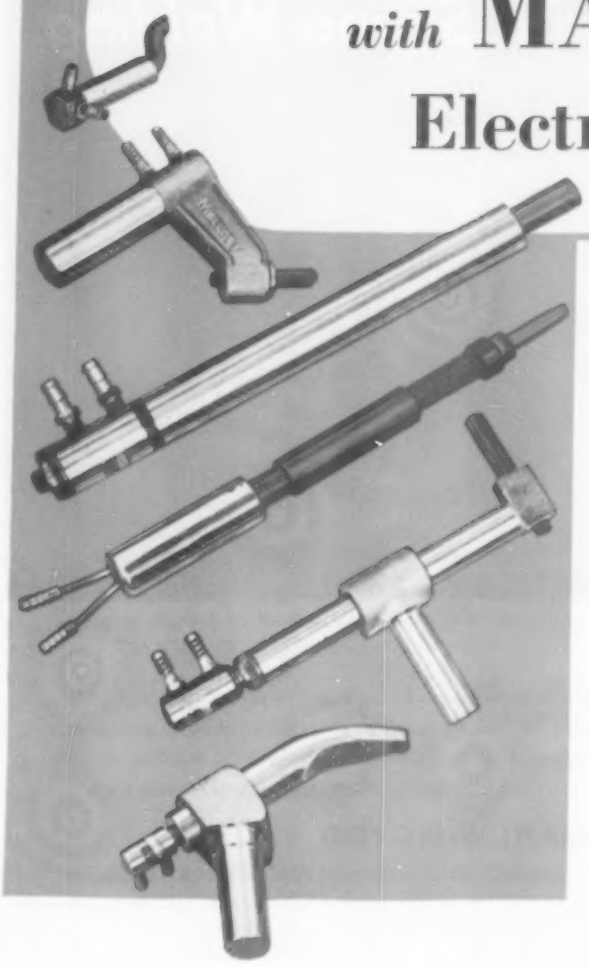

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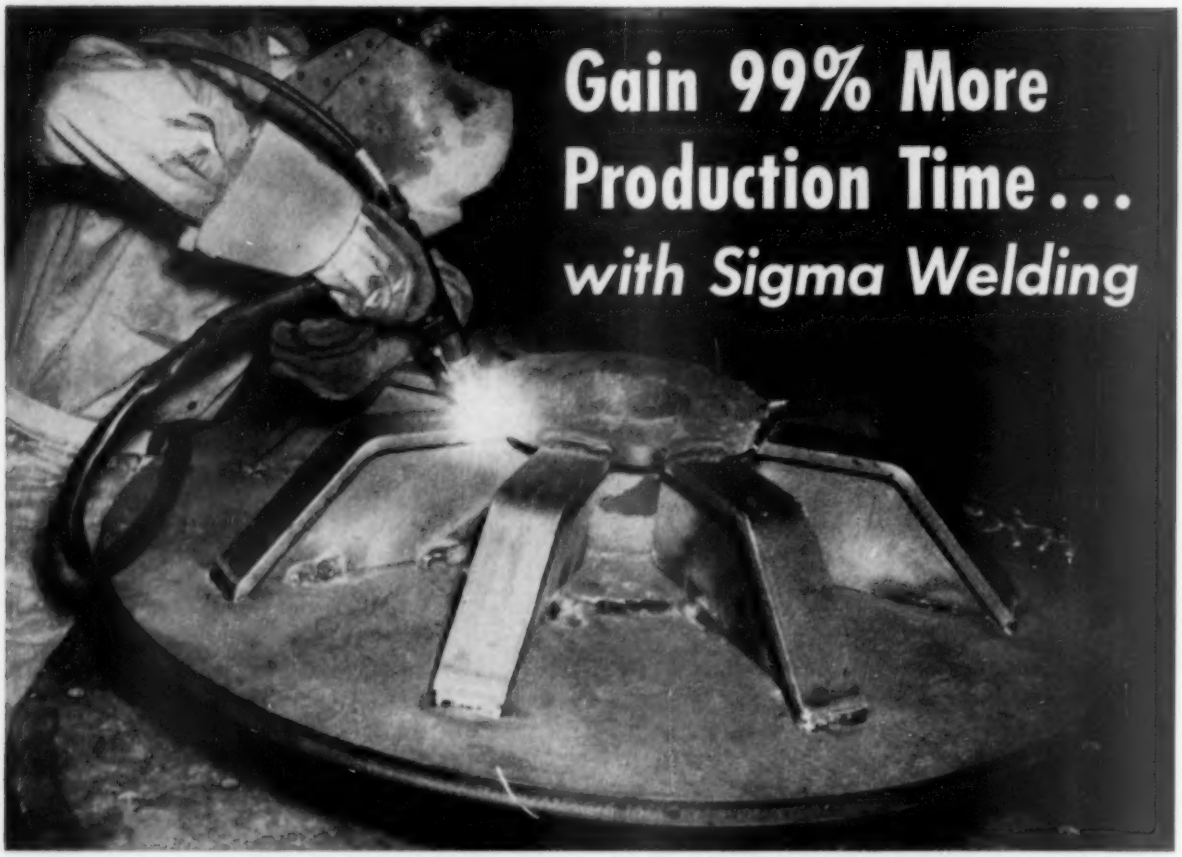

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THE WELDING JOURNAL

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TECHNICAL PAPERS, ITEMS AND REPORTS

Editorial—*Aiming for Higher Quality, by E. E. Michaels* 759

Ultrasonic Welding, by J. Byron Jones and James J. Powers, Jr. 761

Welded Overlay Rotating Bands, by Frank W. Hussey and Irving G. Betz 767

Comparative Properties of Electrodes for Arc Welding Austenitic Manganese Steels, by W. L. Lutes and H. F. Reid, Jr. 776

Automatic Hard Surfacing Saves Pipe and Catalyst, by R. F. Arnoldy 784

Metal-Powder Electrodes and Their Applications, by E. Di Liberti 791

Economics of Welding Small, Noncritical Pipe, by H. A. Sosnin 796

PRACTICAL WELDER AND DESIGNER

Welding Repair Costing $600 Reclaims $8000 Engine Blocks 801

Production of Refrigerator Inner Liners Speeded by Mash-Seam Welding 803

Redesigned Corn Shelling Machines Use End-Welded Studs as Teeth 804

Unusual Fixtures Facilitate Welding 806

SOCIETY AND RELATED EVENTS

Society News 807

Section News and Events 810

New Members 820

Abstracts of Current Patents 823

Current Welding Literature 826

Personnel 827

Employment Service Bulletin 834

News of the Industry 836

New Products 842

New Literature 852

Index to Advertisers 856

WELDING RESEARCH SUPPLEMENT

The Effect of Aluminum Additions to Mild-Steel Weld Metal, by Craig R. Sibley 361-s

Influence of Oxygen on Soundness and Ductility of Molybdenum Welds, by W. N. Platte 369-s

Effect of Notch Orientation on Weld-Metal Impact Properties, by Daniel J. Snyder 381-s

Embrittlement of a Ship Steel in a Nitrate Salt Bath, by D. J. Garibotti, C. A. Beiser and E. B. Evans 383-s

Stress-Corrosion Cracking of Type 304 Austenitic Stainless Steel, by H. L. Logan and R. J. Sherman, Jr. 389-s

Arc-Welding Temperatures, by R. J. Grosh and E. A. Trabant 396-s

Welding the Cupro-Nickels by the Inert-Gas Shielded-Arc Processes, by L. H. Hawthorne and R. F. Burth 401-s

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Fire cracks cast iron flywheel... Ni-Rod "55" repairs 2800-lb. casting

Saves $30,000-$60,000 in downtime loss

Flames leaped up from the transmission belt of this cast iron flywheel early one Sunday morning.

Firemen went to work quickly and cold water from their fire hoses hit a flywheel section and cracked it in two places. The owner was in *hot* water!

The wheel is part of a Corliss steam-engine at Wickwire rod mill, Cortland, N. Y. — the *only* available source of power for 14 roughing and finishing stands of their rod mill.

The damaged casting couldn't be replaced in less than 30 to 60 days. Meanwhile, downtime costs would mount — at the rate of $1,000 a day!

Welding could prevent these losses. But would welds hold firmly as the 2,800-lb. segment spun through space *at more than 60 mph?*

With easy-handling Ni-Rod "55"* electrodes, company weldors produced the *extra* strong welds required — and completed the repair in less than 1 day!

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Even heavy sections of cast iron such as this flywheel, can be welded quickly and easily with Ni-Rod "55" electrodes because of its nickel-iron core wire and *special* flux coating.

Want more information about successful cast iron welding? Our new illustrated booklet gives tips on preparation, welding technique, getting maximum machinability, and more. "A Handy Guide to Welding Cast Irons" is yours on request. *Registered Trademark

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AIMING FOR HIGHER QUALITY

The recent dedication of the entirely new Research Center for U. S. Steel Corporation at Monroeville, Pennsylvania is of much more than usual significance. It marks the awakening of the steel industry to the importance of large scale research.

Continually increasing labor costs are enough to inspire an avid search for improvements in technology. Obviously, elimination of any one or more steps in the rather intricate steel making process would have important results in production costs and in the capital investment required for each new ton of steel capacity. Our interest, however, as users, is focused on studies to improve quality.

Here we start with a product already very good. We demand more and more of this product. And why not? Advancing technology in many industries flaunts the challenge: can steel be produced to withstand higher temperatures?—lower temperatures?—more abrasion?—worse corrosive conditions?—nuclear bombardment? Add other questions if you wish. There must be many more.

We already have so many interesting new high-strength steels that controversies are breaking out all over as to what to do. Surely, most of us believe that we shall see still stronger steels—and soon. Are the designers going to be ready? Are they perhaps dragging their feet right now?

Recently there appeared in this journal a very fine editorial advocating a new concept in joint design. It is certainly a timely subject and it deserves most careful consideration. Our other question concerns the basis for design using the newer steels. Shall it be based on yield or ultimate strength, or possibly on both? Perhaps we can talk a little longer, but soon we shall have to act.

Let us suppose that large-scale research in the steel industry will follow in the path of the chemical and petroleum industries (for instance) and produce both a better and a cheaper product. Will the rest of us—fabricators and users of steel—be caught off base? We shouldn't be.

E. E. Michaels
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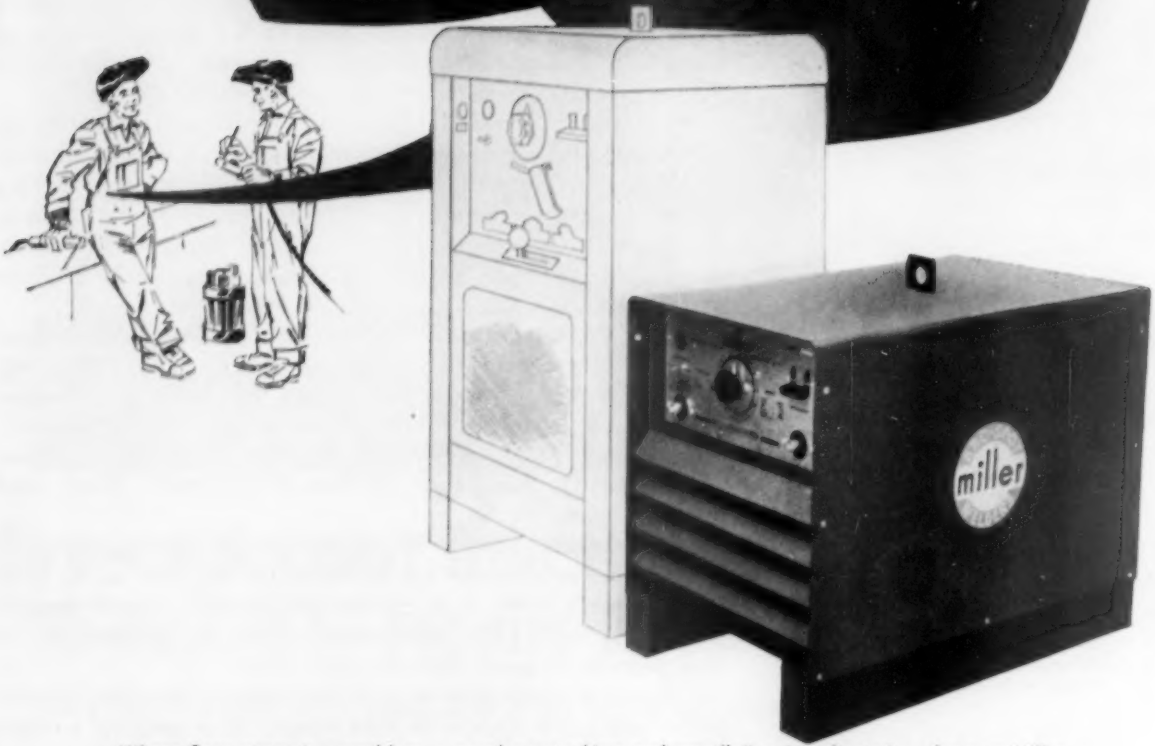

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ULTRASONIC WELDING

BY J. BYRON JONES AND JAMES J. POWERS, JR.

Elastic vibratory energy is introduced into the areas to be joined to effect solid-state bonding between similar and dissimilar metals

SYNOPSIS. Solid-state bonding has been achieved with both similar and dissimilar metals by the introduction of elastic vibratory energy into the metals in the area to be joined. This process may be accomplished without the application of heat except that which is associated with dissipation of the vibratory energy. It is immediately applicable in joining foil and thin sheet to either very thin or massive members.

The presently utilized transducer-coupling system is described, and the controlling parameters of power, vibratory energy exposure time, and static clamping force are discussed.

Both strength and deformation of the weld zone are compared with characteristic values incident to ordinary high-pressure welding for certain metals. The same order of strength has been obtained as with this older technique but with lower deformation.

Representative photomicrographs of characteristic solid-state metallurgical bonds achieved with this process between various similar and dissimilar metals are presented.

Introduction and Background

Ultrasonic welding is a method for bonding similar or dissimilar metals by the introduction of ultrasonic energy into the metals in the area to be joined. In

J. Byron Jones is associated with Aeroprojects Incorporated, West Chester, Pa.; **James J. Powers, Jr.,** is Metallurgist, Pitman-Dunn Laboratories, Frankford Arsenal, Philadelphia, Pa.

Presented at the 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7-11.

The Statements and opinions appearing in this paper are those of the authors and do not necessarily reflect the views of the Ordnance Corps, Department of the Army.

connection with this process, *ultrasonic energy* is defined as high-intensity and/or high-frequency elastic vibration. The pieces to be joined are clamped at low pressure between two welding members or sonotrodes, specifically designed for each type of weldment, and the vibratory energy is introduced for a brief interval, generally 1 to 3 sec. Solid-state metallurgical bonds are thus produced with insignificant external deformation of the pieces.

During the past four years of experimentation and development with this process, good bond strength has been obtained in ultrasonic sheet-to-sheet welding of a number of metals, as will be shown later. Ultrasonic welding of this type appears to achieve roughly the same order of strength, at least with aluminum, as does the older technique of high-pressure welding. For example, published data show apparent shear strengths ranging from 5300 to 9800 psi for pressure welds in 1100 aluminum alloy,[1] as against readily achieved 7900 psi for ultrasonic welds.

However, ultrasonic welding differs from ordinary pressure welding in that bonding is accomplished:

(*a*) Without meticulous attention to surface preparation
(*b*) With inconsequential deformation (<5% instead of 60–80%)
(*c*) With lower applied static compressive loads

Using an ultrasonic welding array which evolved from that used in earlier work, the first so-called "welds" in foil thicknesses of soft aluminum were accomplished and the strength of the small, adhering, spot-like areas was measured on a gram scale. From this beginning, the process has been developed to the stage in which single weld strengths measured in hundreds of pounds can be achieved with a variety of materials of reasonable thickness.

It has been demonstrated that ultrasonic welding can be successfully used, not only for the joining of flat sheets, but also for a variety of other configurations. Diminutive ribs have been welded to flat aluminum plates and to long tubes in a spiral configuration. However, to achieve its present state of development, several problems had to be recognized and solved.

Basic Problems in Ultrasonic Welding

In order to clarify the concept of ultrasonic transducer-couplings, a brief explanation follows.

The transducer is the device which converts alternating electric current into mechanical vibration. It can be a stack of nickel laminations, barium titanate ceramic, natural or artificially grown crystals, an electromagnetic device, etc. A radio loudspeaker is a transducer.

The coupling is the medium—in this case, metal members—which conducts mechanical vibration from the transducer to the work area. In the radio loudspeaker analogy, the coupling is the air between the speaker and the ear.

The transducer-coupling system includes the transducer, the coupling between members, the mountings to support these, the contacting tips between the coupling and the work, and the reflector sonotrode.

The resonant frequency of the transducer-coupling system should be the design frequency of the complete system. The transducer is designed to operate at a particular frequency, and the coupler is designed to resonate at the same frequency.

The transducer-coupling system associated with earlier work,[2] and basically the one from which ultrasonic welding transducer-coupling systems have evolved, was inefficient for several reasons:

1. Data were not then established nor reduced to engineering utility; in fact, not very much was known about transmitting elastic vibration through metal members at power levels, although basically such a system follows the theory of electric power-line transmission.

2. The early systems were "force-sensitive"; i.e., when a force was applied through the system, it resulted in a shift in resonant frequency of the transducer-coupling system to such an extent that matching or tracking with the alternating-current power source was not feasible.

3. The mountings absorbed great amounts of energy, so that little was delivered to the work point—the weld area.

4. Energy traveled beyond the work point; to do effective work, the energy should be dissipated exactly where the work is to be done—in the weld area.

At that time, there was no satisfactory mounting method that would permit force application through the transducer-coupling system without (*a*) removing a large amount of energy from the system or (*b*) producing an unacceptable shift in the resonant frequency of the transducer-coupling system.

Presently Best Welding System

With recognition of these problems, efforts were di-

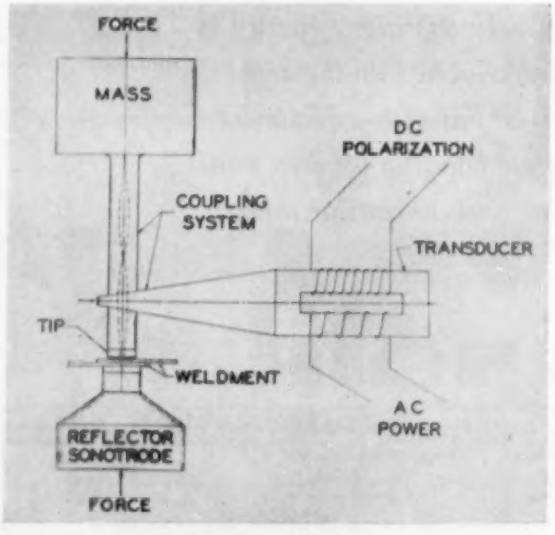

Fig. 1 Transducer-coupling system

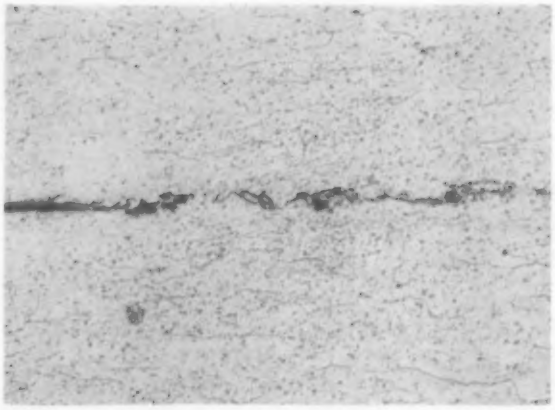

Fig. 2 Edge section of ultrasonic weld in 0.032-in. tabs of 1100-H14 aluminum alloy. Energy = 1500 watt-sec; weld area = 0.037 sq in.; unit shear strength = 6470 psi. (0.5% HF etch; X 280)

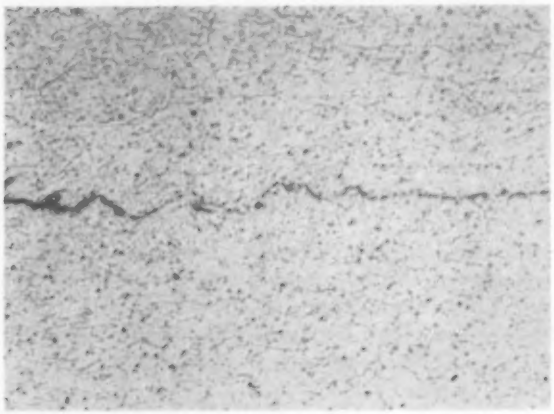

Fig. 3 Edge section of ultrasonic weld in 0.032-in. tabs of 5052-H32 aluminum alloy. Energy = 1350 watt-sec; weld area = 0.152 sq in.; unit shear strength = 15,590 psi. (1.0% HF etch; X 150)

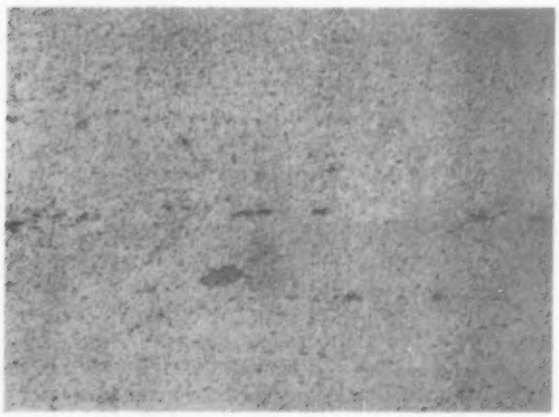

Fig. 4 Ultrasonic weld in 0.040-in. tabs of M-257 aluminum. Energy = 2100 watt-sec; weld area = 0.025 sq in.; unit shear strength = 11,120 psi. (0.05% HF etch; X 400)

rected to finding solutions to them. Some of the best welds to date have been produced with the transducer-coupling system shown in Fig. 1. It is evident that this system delivers a combination of shear and compression vibration to the plane of the weldment. It is not "force-sensitive"; very little energy is lost to the mounting system, and its resonant frequency does not shift; its design is such that much of the delivered energy is localized in the weld zone.

The transducer is a stack of nickel laminations, each about 10 mils thick, with a low d-c voltage polarization source, about 5 amp at less than 1 v. The alternating current is supplied by an electronic generator at the design frequency of the transducer-coupling system, preferably in the range of 4 to 40 kc, depending upon the characteristics of the transducer-coupling system and other factors.

Recent investigation of the power factor in the a-c circuit reveals the applied power to be in the range of 100 to 1800 true watts effective to the transducer under various conditions. There is some indication that an instantaneous value at initiation of the welding pulse may be higher. Acoustical watts delivered to the weld area are less than the a-c watts delivered to the transducer.

Controllable Ultrasonic Welding Variables

Static Force

The static force applied to materials that have been ultrasonically welded has been in the range of 10 to 350 lb. Excessive static force will produce needless surface deformation in the weldment. The static force normally associated with ultrasonic welding seems to be dependent upon the following factors: the properties of the material being welded, the thickness of the thinnest member of the weldment, the ultrasonic power being utilized and the geometry of the welding tips. In general, low static forces are associated with (*a*) small welds, (*b*) thin materials, (*c*) soft materials, and (*d*) low power. Greater static forces are associated with (*a*) larger welds, (*b*) heavier materials, (*c*) hard materials, and (*d*) higher power.

Tip Geometry

Throughout the development of ultrasonic welding to date, it has been expedient to use welding tips of spherical geometry having radii between about 1.0 and 6.0 in. A large portion of the work has been done with a spherical tip with a 3-in. radius. The reflector sonotrode has a flat surface.

Frequency

It has been clearly established that vibratory welding can be accomplished over a broad frequency range. Much of the work to date has been accomplished within the frequency range of 4000 to 40,000 cps. It is believed that thinner materials respond to the higher frequencies and that thicker materials respond to the lower frequencies.

Ultrasonic Power

The electrical power used to date has been in the

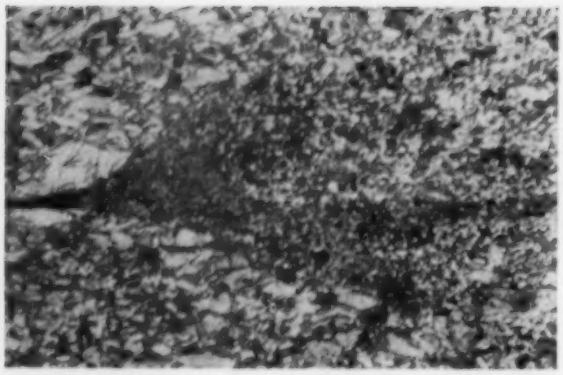

Fig. 5 Edge section of ultrasonic weld in 0.010-in. tabs of spring-temper cartridge brass. Energy = 2100 watt-sec; weld area = 0.010 sq in.; unit shear strength = 22,570 psi. (NH_4OH + H_2O_2 etch; X 150)

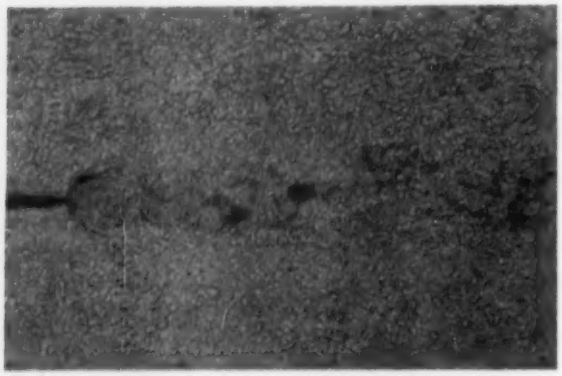

Fig. 6 Edge section of ultrasonic weld in 0.025-in. tabs of electrolytic copper. (NH_4OH + H_2O_2 etch; X 100)

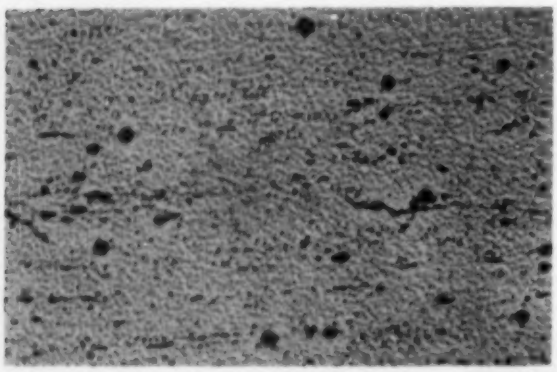

Fig. 7 Ultrasonic weld in 0.025-in. tabs of FS-1h magnesium alloy. Energy = 1350 watt-sec. (HNO_3 + CH_3COOH + alcohol etch; X 150)

range of up to about 1800 w and transducer-coupling systems within and above this capacity have been developed. In general, harder and thicker materials require more power, while the thinner, softer materials require low power, as low as approximately 200 w.

Ultrasonic Exposure Time

Under ordinary circumstances, ultrasonic welding is accomplished in from 0.5 to 1.5 sec per weld. Some work has been done with times as short as 0.10 sec and as long as 6.0 sec.

Factors Associated with the Mechanism of Ultrasonic Welding

Stress Distribution in the Weld Zone

Evidence already exists that welding is accomplished at least partly as a result of deformation at the interface being welded. This deformation results from stresses introduced into the weld zone by the static force applied through the welding tips, on which are superimposed oscillating stresses associated with delivery of the elastic vibratory energy. The process achieves considerable deformation at the interface being welded, with relatively little deformation at the surface where the static force and elastic vibratory energy are applied. Measurements show that the external deformation is in the order of 0–5% of the total thickness of the sheets being welded. Inspection of numerous microsections reveals internal deformations amounting to as high as 80% when the materials are of foil thickness; in thicker sheet materials, the actual internal displacements are of the same order as in thin foils, the percent internal deformation thus being lower with increased sheet thickness.

Investigations associated with ball-bearing failure and other problems[3, 4] seem to have established the fact that substantially higher stresses can exist below a surface contacted by a spherical indenter than exist at the contact area between the indenter and the material it presses upon.

The photomicrograph of the copper weld (Fig. 6) well illustrates internal deformation, and the evidence of cold work adjacent to the interface in the steel micrograph of Fig. 9 is clear.

Based on the evidence of the above-mentioned photomicrographs, it is reasonably certain that ultrasonic welding results from the ability of certain contacting force-member geometries which are cyclically displaced very slightly and very rapidly, to produce dynamic internal stress distributions sufficient to cause internal plastic flow at the interface undergoing welding.

Since shear and compression vibration was established as one of the modes for making ultrasonic welds, a number of mechanisms have been postulated as means for accomplishing this type of welding. The theory that seems to stand up best says that there is a sort of jelly island existent in the sheets around the weld zone which deforms elastically and plastically. At the interface, these islands may be moving somewhat in opposition to each other, and the surfaces in contact execute local plastic deformation, perhaps somewhat resembling a reversing fluid boundary layer. This process is continued until sufficient weld area is built up so that there is insufficient power to cause further internal plastic deformation.

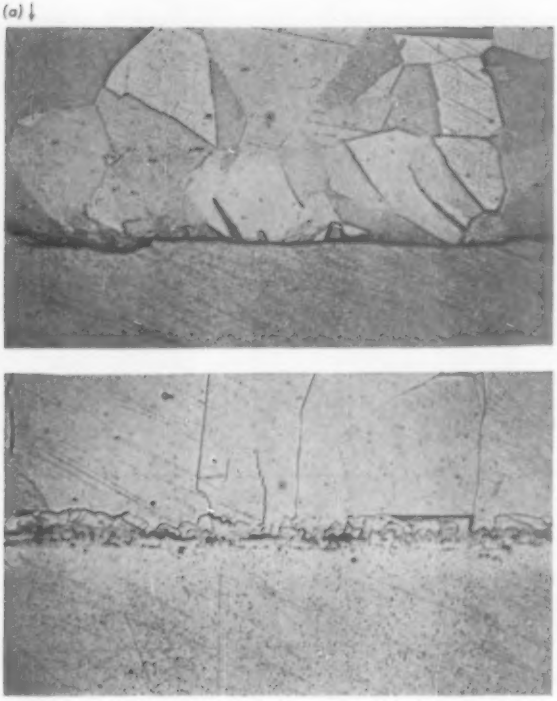

Fig. 8 0.008-in.-thick gold-platinum alloy ultrasonically welded to 0.008-in. pure nickel; energy = 1400 watt-sec. (*a*) As-welded. (*b*) Recrystallized for 30 min at 1450° F. ($KCN + (NH_4)_2S_2O_8$ etch; X 340)

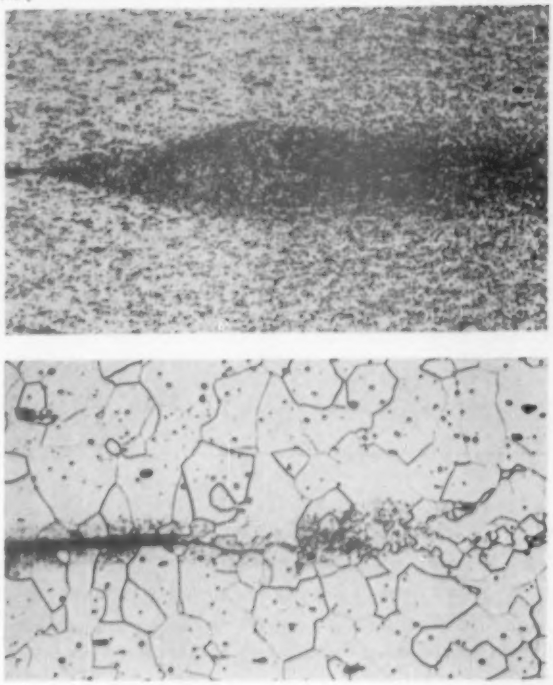

Fig. 9 Edge section of ultrasonic weld in 0.010-in. tabs of 400 series stainless steel; energy = 825 watt-sec. (*a*) As-welded (X 120). (*b*) Recrystallized for 30 min at 1450° F (X 260). (Picral etch)

Net Energy Delivered to the Weld Zone

The elastic vibratory energy delivered to the weld zone (*a*) generates surface and internal stresses in the weldment, (*b*) produces elastic and plastic deformation in the weld zone, generating heat and resulting in an associated temperature rise, and (*c*) can traverse the weld zone and be dissipated elsewhere. It is clear that accurate measurement of the net energy delivered to the weld zone is fundamental to the ultrasonic welding process. However, precise determination of this energy is not straightforward.

Temperature Developed in the Weld Zone

Elastic hysteresis and plastic deformation become manifest as a temperature rise in the materials being welded, transiently affecting their properties. Effort has been expended to become acquainted with this aspect of ultrasonic welding. Theoretical analysis, based on assumed energy dissipated in the weld zone, a planar heat sink and the thermal properties of aluminum, indicated a possible temperature of about 600° F. Two experimental approaches have been used; first, that of embedding small thermocouples at the interface of two aluminum sheets prior to welding and recording their output with an oscillograph having a response of 100 cps; second, by the formation of ultrasonic welds between different materials which, during welding, acted as thermocouples and fed the same recording system. The first method, with two sheets of aluminum, indicated a temperature of about 400° F; the second approach, using sheet Monel against sheet aluminum, indicated a temperature approaching 1000° F. For reasons associated with the different material properties, especially thermal properties, the data are not comparable, but probably the bimetal weld produced a better indication of microscale temperatures.

Neither system recorded temperatures approaching the melting temperature of the lowest melting material of the weldment, and microscopic examination has revealed nothing indicative of fusion. This clearly indicates that ultrasonic welding is a solid-state phenomenon.

Inasmuch as the temperature developed in the weld zone strongly influences temporary properties of the weldment materials, this facet of ultrasonic welding is obviously significant.

Properties of the Material Being Welded

No metal has been encountered to date which could not be ultrasonically welded, although ultrasonic welding of every metal or metal combination has not been attempted. Listed below are some of the highly tentative conclusions that have been reached regarding the ultrasonic welding process and its relation to material properties.

(*a*) Very soft materials, such as annealed 1100 aluminum alloy, are somewhat more difficult to weld than harder alloys.

Table 1—Strength of Ultrasonic Welds in Several Materials

Material	Alloy designation	Sheet thickness, in.	Energy to accomplish welds, w-sec	Applied static compressive stress, psi	Shear fracture strength, lb	Weld area, sq in.	Unit shear strength, psi	Published shear strength, psi
Aluminum	1100-H14	0.040	1500	7,000	288 + 42 − 53	0.036	7,980	11,000
Aluminum	5052-H32	0.032	1350	12,500	210 ± 40	0.016	13,050	20,000
Aluminum	6061-T6	0.032	1650	30,900	109	0.008	13,460	30,000
Aluminum	M-257	0.040	2100	8,000	287 + 44 − 21	0.025	11,470	...
Cartridge brass	70-30(1/2H)	0.016	1050	22,700	250 + 20 − 28	0.011	22,730	40,000
Cartridge brass	70-30(H)	0.016	1050	30,900	275 + 11 − 30	0.008	33,950	44,000
Stainless steel	316	0.020	900	28,600	178 + 44 − 34	0.007	25,800	...

(*b*) Bimetal welds can be achieved more readily when the hardness of the two metals is not too far apart.

(*c*) Microhardness studies on welds in several aluminum alloys do not indicate a substantial increase in hardness over that of the surrounding metal.

(*d*) Weld area increases with thickness of material to a limiting value above which welding has not yet been possible, and this limit is different in different materials.

(*e*) Smaller welds are achieved in hard materials than in soft materials.

(*f*) The thermal properties of a material affect its ultrasonic weldability.

(*g*) While surface cleanness and surface films do affect ultrasonic welding of materials to some extent, they need not be as carefully controlled as for pressure welding. Ultrasonic welding of low-carbon steel has been accomplished directly through highly adherent plastic films; aluminum has been anodized to film thickness of 500Å and successfully welded.

The significance of material properties requires extensive investigation, and the fact that ultrasonic welds are produced under conditions of triaxial restraint is being considered.

Present Status of Ultrasonic Sheet-to-Sheet Welding

The present status of ultrasonic sheet-to-sheet welding is roughly indicated in Table 1. It should be emphasized that no heat was introduced during welding of any of these materials except that which was associated with degradation of the vibratory energy.

The photomicrographs of Figs. 2–9 show ultrasonic welds in several materials. It will be noted that the strength data do not correspond exactly with those given in Table 1. The data accompanying the micrographs have been assembled over many months and apply only to the specific groups of welds from which the sectioned and photographed specimens were taken.

Presently Feasible Uses

1. Foil-thickness materials can be metallurgically joined and the bonds have very substantial area as compared with fusion welds in such materials.

2. Foil-thickness materials can be joined to heavy plate, rods or tubes. So far as is known, it is not feasible by any other method to achieve welds of considerable area between, for example, 1-mil foil and 1-in. plate.

3. Small buttons of one metal can be joined to heavier sheet, plate or ribbon to produce the type of joints which might be desired for electrical contacts.

4. The welding of sintered aluminum powder products, and probably other sintered powdered materials as well, can be effected.

5. Copper in gages at least up to 0.040 in. can be ultrasonically welded without excessive power requirements.

6. The process can probably be used for joining dissimilar metals where existent methods are impractical.

7. The hermetic sealing of small containers, such as impact extrusions, squeeze tubes, etc., may be effected.

Acknowledgment

The authors are indebted to Mr. A. L. Jamieson, Director of Technical Services of Pitman-Dunn Laboratories, Frankford Arsenal, Department of the Army, for his imagination and enthusiasm in initiating the program.

References

1. DeCecco, N. A., and Parks, J. M., "Recrystallization Welding of Aluminum Aircraft Alloys," *WADC Tech. Rept. 53-281*, December 1953.
2. Jones, J. B., Turbett, F. J., and Kane, J. V., "Exploratory Research on the Application of Ultrasonics to Spotwelding," *Aeroprojects Research Rept. No. 50–5*, August 1950. Also, Jones, J. B., DePrisco, C., and Meyer, F. R., "Investigations of Ultrasonics Applied to Spotwelding," *Aeroprojects Research Rept. No. 53-18*, June 1953. (Work done for Airborne Equipment Division, Bureau of Aeronautics, Department of the Navy.)
3. Frocht, M. M., *Photoelasticity*, Vol. 1, John Wiley & Sons, New York (1941).
4. Hunt, F. V., "Elastic-Plastic Instability Caused by the Size Effect and Its Influence on Rubbing Wear," *Jnl. Appl. Phys.*, **26**, 850–856 (1955).
5. Jones, J. B., and DePrisco, C. F., "The Application of Ultrasonic Energy to Cold Welding of Metals," *Aeroprojects Research Rept. No. 53-77*, November 1953. (Work done for Frankford Arsenal, Philadelphia Ordnance District, Department of the Army.)
6. Jones, J. B., DePrisco, C. F., and Thomas, J. G., "Ultrasonic Welding of Metals," *Aeroprojects Research Rept. No. 55–30*, April 1955. (Work done for Frankford Arsenal, Philadelphia Ordnance District, Department of the Army.)

Application of welded overlay rotating bands on a variety of projectiles

WELDED OVERLAY ROTATING BANDS

Rotating bands applied to projectiles by the inert-gas-shielded metal-arc process with the aid of an auxiliary filler wire have shown great promise in ballistic tests, in technical feasibility and in economy

BY FRANK W. HUSSEY AND IRVING G. BETZ

ABSTRACT. Rotating bands act as obturators on projectiles and also are engraved by the barrel rifling to impart the spin which provides stability in flight. The conventional band is machined from a blank which is swaged into a preformed seat in the wall of the projectile. It depends upon a mechanical bond to withstand the forces incident to firing. A new method, employing welding, has been developed. Bands are derived from overlays deposited directly on the projectile. Advantages include a fusion bond, conservation of metal and fabrication economies.

Welded bands have been applied to many steel projectiles of various calibers. Immediate ordnance requirements have been met with welded overlay bands of copper alloys. The minimum heat required for braze-welded bonds in overlayed copper alloys has contributed to the success of this method on thin-walled items and on cold extruded shells. Overlays of soft iron, also, have shown great promise.

The inert-gas metal-arc welding process has been favored for this application. The basic process, however, was modified by introducing an auxiliary wire into the weld puddle. This minimized penetration and dilution and greatly decreased the time required for overlaying. Stringer beads were replaced with the weave bead technique for obtaining the desired width of overlay. Coatings and gas mixtures were explored.

The welded band has favorably approached the advanced stages of controlled procedures and ballistic evaluation. Its technical and economic advantages assure wide acceptance.

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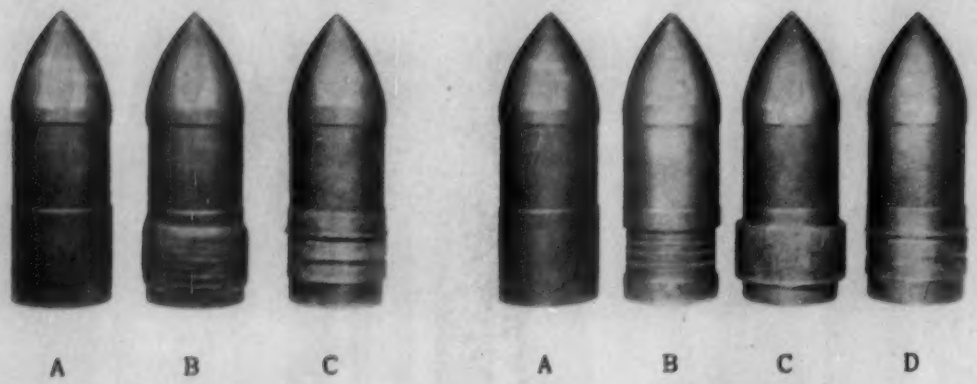
Introduction

A welding method of applying rotating bands to projectiles has been conceived and developed by the Pitman-Dunn Laboratories of Frankford Arsenal. The rotating bands are machined from overlays of various metals and alloys which are deposited by the inert-gas-shielded metal-arc (consumable electrode) welding process with the aid of an auxiliary filler wire. This adaptation of conventional welding is known as the welded overlay rotating band process. The welded band has shown great promise in ballistic tests, in technical feasibility and in economy. Its many advantages place it in a competitive position with conventional bands and those new bands which are under development. These advantages are as follows:

1. No band seat required, which will (*a*) reduce machining costs; (*b*) save band material; and (*c*) permit thin-walled shell with increased explosive capacity.
2. Fusion bond replaces mechanical interlock.
3. Favorable and uniform ballistic performance.
4. Choice of overlay metals and alloys, permitting conservation.
5. Light and inexpensive machinery needed for welding.
6. Reduced labor costs.
7. Fewer operations.
8. Reduced handling costs.
9. Lower total production costs.

Research and development on welded overlay rotating bands has been in progress for five and one-half years. During this time, a vast amount of unpublished data has been accumulated. In this paper the authors



Sequence of operations for welded overlay rotating band

1. Shot machined, A
2. Overlay (aluminum bronze) deposited, B
3. Overlay finish-machined into band, C

Sequence of operations for standard gilding metal band

1. Shot machined, A
2. Band seat machined
3. Band seat knurled, B
4. Band blank annealed and pickled
5. Band blank swaged into band seat, C
6. Band finish-machined, D

Fig. 1 Comparison of conventional and welded overlay methods of banding

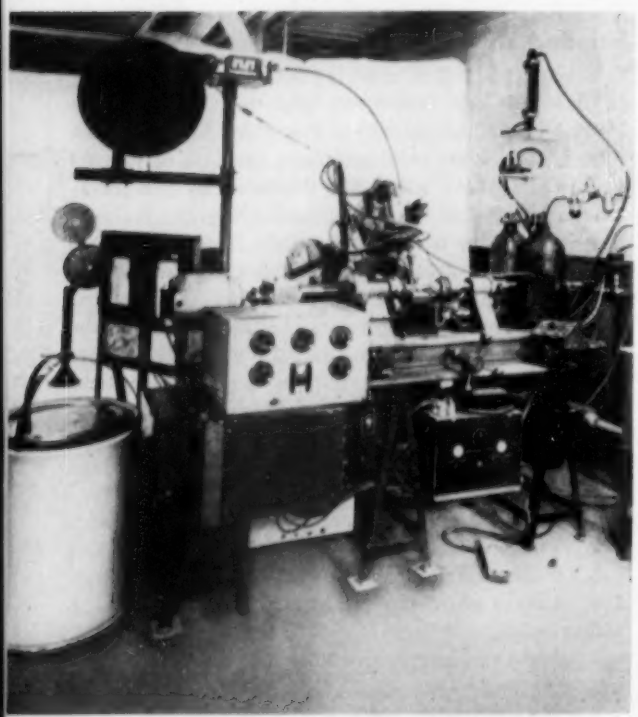


Fig. 2 Laboratory setup for overlaying small caliber projectiles

attempt to summarize the unclassified information which has been gathered.

A rotating band fulfills two and sometimes three requirements in promoting satisfactory performance of a projectile. The band serves as an obturator for all ammunition, following ignition of the propellant, thereby permitting the build-up of pressure for propulsion. The rotating band also engages the rifling of the gun barrel and is engraved to impart spin to the projectile for stability along its trajectory. An exception is the band of the recoilless rifle projectile which is preengraved during manufacture. Finally, in separated ammunition and in separate loading ammunition, i.e., where the propelling charge and projectile are separate units, the band fixes the forward position of the projectile when it is rammed "home" before firing.

The conventional method of banding is the swaging of an annealed and pickled ring (band blank)—usually made of copper or gilding metal—into an undercut and knurled band seat. This provides a mechanical interlock between the band and the projectile. The welded overlay rotating band, however, becomes an integral part of the projectile because of the fusion bond. This prevents the band from loosening or separating from the projectile during its flight. The conventional and welded overlay methods are compared in Fig. 1.

The idea of welded overlay rotating bands was conceived during experiments with the attachment of windshields to armor-piercing shot (solid projectiles). Difficulties associated with tack welding, using coated electrodes, led to a trial of the inert-gas metal-arc (consumable electrode) welding process. The quality of the welding beads and the ease of applying them to the shot suggested the possibility that a single bead or several overlapping beads could be machined into a rotating band. The feasibility of banding by welding was

readily demonstrated. Firing tests at low and high velocities indicated the reliability of welded overlay rotating bands.

Welding Processes, Equipment, and Techniques

The development of welded overlay rotating bands has centered around the inert-gas metal-arc (consumable electrode) process. A single exception, however, was an initial evaluation of the submerged-arc process for applying soft ferrous overlays. The submerged-arc overlays were softer than any which have been deposited by the other process. This paper, however, deals entirely with the inert-gas metal-arc (consumable electrode) welding process.

The equipment which was employed for research and development consisted of welding heads, devices for rotating the work, auxiliary wire feeders, welding power sources, flow meters, the usual electrical meters, and control and auxiliary equipment. The commercial "automatic" welding heads were satisfactory with certain modifications. The problems of "burn-back" and "stubbing," for instance, required the installation of overvoltage control and dynamic braking, respectively, for small caliber applications in which the sequence of events was more critical. Typical laboratory equipment used for overlaying small caliber projectiles is shown in Fig. 2.

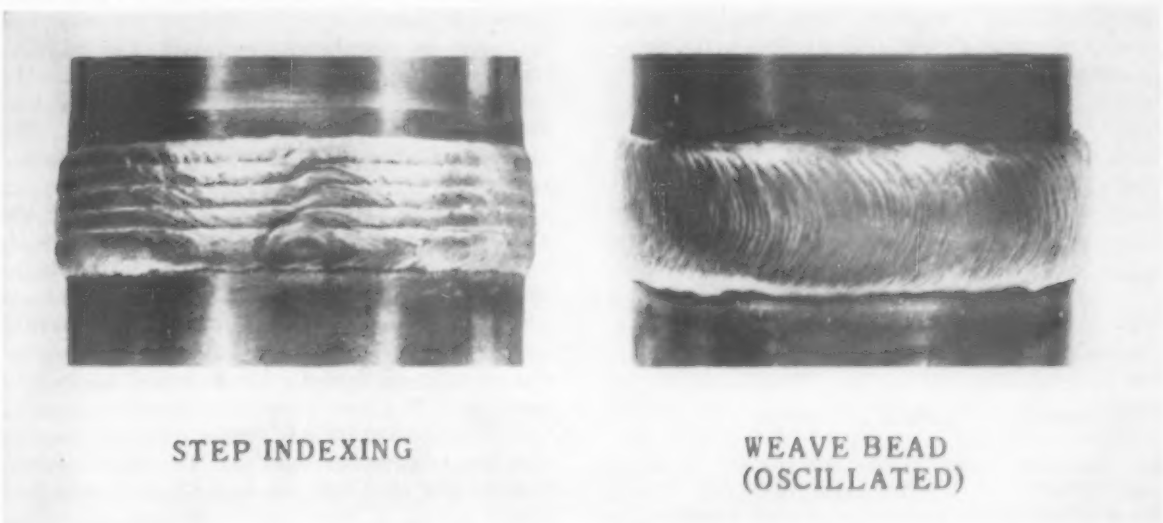
The projectiles were rotated in modified lathes or similar apparatus which also supported the welding head, auxiliary wire feeder, control panels, etc. A steady and dependable means of rotating the work was essential. This was provided in a commercial motor controller which utilized an adjustable autotransformer to control the armature voltage of a d-c motor. Standard motor-generator sets supplied the d-c welding power. Sequence timers became a necessity for small caliber work and were also found to be of value in all of the overlaying for banding.

An important innovation in the basic welding process was the introduction of an auxiliary, nonelectrode, or "cold" wire into the arc. Although the cold wire addition increased the rate of deposition, its principal advantage was its chilling effect upon the puddle. As the cold wire feed was increased, penetration and pickup decreased. The cold wire provided a means of introducing alloying elements, greatly reduced the time required for overlaying and had a pronounced effect in reducing cracking in ferrous overlays. The cold wire, however, was not a part of the electrical circuit.

The rotating bands on artillery projectiles and on rocket motor bodies are usually wider than a stringer bead deposited in a single revolution. Therefore, continuous and overlapping beads were deposited in two or more revolutions, either by spiraling or by step-indexing. Spiraling was employed for only a short time because of the extra metal required at each end of the spiral. This was followed by a step-indexing procedure which was used extensively for overlaying Armco iron. In this method, the welding head was rapidly indexed at the end of each revolution. The weave bead, however, eventually displaced the other methods of achieving the desired width. The overlays derived by step indexing and by oscillating the welding head are shown in Fig. 3. The weave-bead technique greatly reduced the cost of equipment since it was cheaper to oscillate the welding head than to provide mechanisms for indexing. The weave bead resulted in more uniform hardnesses, reduced penetration, and provided better bead contours for this application.

It was necessary in many instances to cool the projectile during the welding operation. This was done in order to preserve the mechanical properties of the projectiles and to minimize penetration, particularly in overlaying thin-walled shells. The cooling of shell (hollow projectiles) was readily accomplished by injecting either air or water into the shell cavity while

Fig. 3 Comparison of step-indexing and weave-bead techniques



welding. A tubular device was inserted in the shell, either manually or mechanically, through a hollow tail stock which also provided for drainage. The cooling of solid projectiles presented a greater problem. These were sometimes overlayed with the lower one-third of the projectile immersed in water.

The positions of the electrode and cold wire with respect to the projectile significantly affected the results, as shown in Fig. 4. When the arc was located toward the top, the deposit, was too high, severely peaked and tended to be undercut. The location of the arc too far downhill caused the loss of control of the puddle and runoff. The optimum position for the arc was as far downhill as possible, consistent with the maintenance of control. The cold wire guide was placed as close as possible to the shell and slanted upward a few degrees so that the wire was in line with the electrode and nearly tangent to the projectile. The welding head was tilted about 10 deg from the vertical, as shown in Fig. 4.

Filler Metals

General

The filler metals used in the initial tests were the readily available varieties of copper, silicon bronze, aluminum bronze and unalloyed iron. The bands derived from these overlays varied greatly in hardness, but all functioned satisfactorily in preliminary firing tests. It was intended to exploit the nonferrous materials because of their adaptability to welding and their similarity to conventional band materials. The prospect of conserving copper, however, aroused great interest in the overlayed iron band. The initial program was devoted, therefore, to the development of a welded iron overlayed rotating band for the 105-mm M1 howitzer shell.

Iron Filler Metal

A ready source of practically unalloyed iron filler metal was Armco iron. This was available in wire form with a flash coating of copper. This filler metal, containing 0.02% C and 0.04% Mn was deposited on forged SAE 1050 steel shells. The resulting ferrous overlay resembled an SAE 1015 steel due to the pickup of carbon and manganese from the base metal.

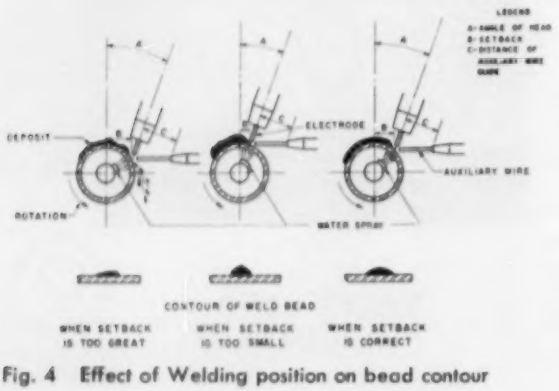


Fig. 4 Effect of Welding position on bead contour

The hardness of the first ferrous bands, at Rockwell B 85–90, was approximately double that of the conventional swaged gilding metal bands. This hardness was reflected in extremely high engraving pressures during static tests. It was evident that a softer deposit was essential and that the band might have to be redesigned. Through refinements in welding and by induction annealing the overlay, it was possible with these earlier procedures to fabricate a welded ferrous band with a hardness of R_B 70–72.

Fluorescent penetrant inspection of the first ferrous overlays revealed fine cracks. These did not extend to the base metal and did not affect the functioning of the shell. The existence of cracks, however, was considered a major deterrent to the acceptability of these overlays and a great effort was made to eliminate them. Finally, the use of a "cold" or nonelectrode wire, together with the electrode, was found very effective in reducing cracking. The cold wire permitted higher currents and wire feeds and greatly reduced the welding time. It also effectively reduced the need for interior cooling of the shell during welding. The 105-mm M1 band initially required five continuous and overlapping beads to get the $1^1/_8$ in. width. With the advent of the "cold wire" technique, the number of beads was decreased from five to four, and finally to three. The time for overlaying was concurrently reduced from five minutes to one minute and twenty seconds.

Spatter from the welding arc was a constant source of annoyance and an obstacle to production. Spatter adhered to the shell and accumulated in the welding nozzle, which was tapered internally and polished with fine emery cloth to decrease adhesion and to simplify removal of the spatter. An atmosphere of helium gas was found to be more effective than either argon or the few gas mixtures that were tried for the stringer beads using plain Armco iron.

The weave-bead technique further improved the ferrous overlay by providing an even contour and more uniform hardness. When employed with an aluminum-coated cold wire, this procedure greatly reduced the porosity in ferrous overlays. Spatter was minimized by using the aluminum-coated cold wire with an emissive-coated electrode in a shield of argon. The emissive coating was a current-conducting agent that improved metal transfer and arc characteristics. The aluminum coating effectively deoxidized the molten weld metal.

A significant improvement in the iron overlay was made with the a-c series arc technique. Weave beads were applied on 90-mm shell, using two emissive-coated electrodes along with two aluminum-coated cold wires. The ferrous overlays applied with this method were free from cracks and porosity, and weld spatter was virtually eliminated. The as-welded hardness of Rockwell B 70–73 was lowered by induction annealing to R_B 60 to 65 and could be further reduced if the shell were heat treated after welding. The reduced penetration provided an overlay resembling SAE 1008 to 1010 steel. A shield of argon gas was employed.

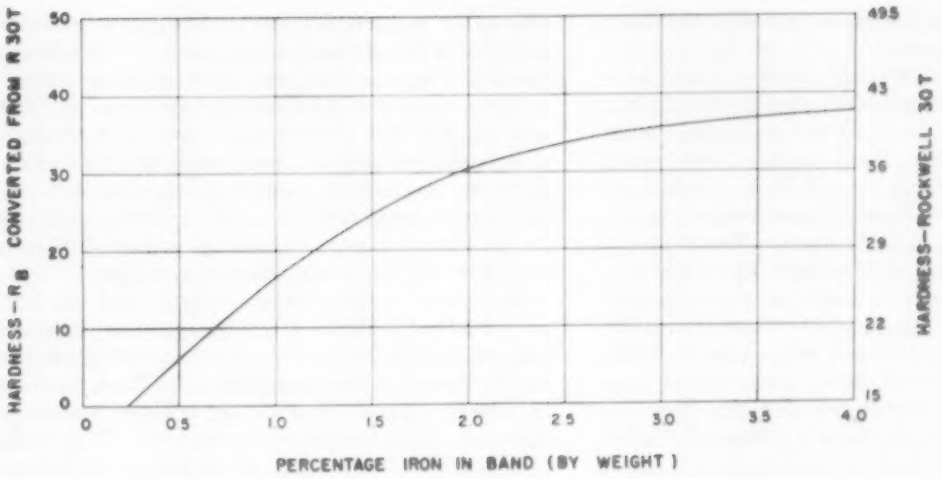


Fig. 5 Effect of iron on hardness of copper overlays

Copper-Alloy Filler Metals

General. An uncertainty regarding the erosive effect of the ferrous bands on the life of the gun tube, however, delayed their acceptance. The major emphasis in the development effort was transferred to copper alloys in order to meet an urgent need for bands for thin-walled steel projectiles.

In applying copper-alloy overlays, it was desirable to establish a braze-welded bond with a minimum pickup of iron. The effect of iron on the hardness of copper overlays is shown in Fig. 5. This curve was derived from the results of tests on 30-mm shell. In view of its effect on the hardness of overlays, it was recommended that iron be kept below 1%. Greater hardnesses and strengths, if required, should be achieved by alloy filler metals. The cold wire was essential in controlling the amount of iron pickup. It was started before the electrode wire so that the arc did not impinge entirely on the projectile. This minimized the deeper penetration which was previously experienced at the start of the weld.

The application of single overlapping beads proved to be unsatisfactory with the copper alloy. The high heat conductivity of these beads, compared with that of the steel projectile, greatly affected the welding conditions for subsequent passes which were to overlap those previously applied. Higher current densities were required and penetration was hard to avoid. The width was best achieved, therefore, by oscillating the welding head. For bands over 2 in. wide, it was necessary to overlay two or more weave beads. These were not readily joined by overlapping but were connected with single stringer beads.

Rotating bands normally have relatively low and wide sectional contours. The copper-alloy filler metals come closest to providing the best bead shape for this application in that they have better wetting and flow characteristics than iron.

Copper Filler Metal. The filler metal currently in use for production is a proprietary silicon-deoxidized copper, containing small amounts of tin and manganese

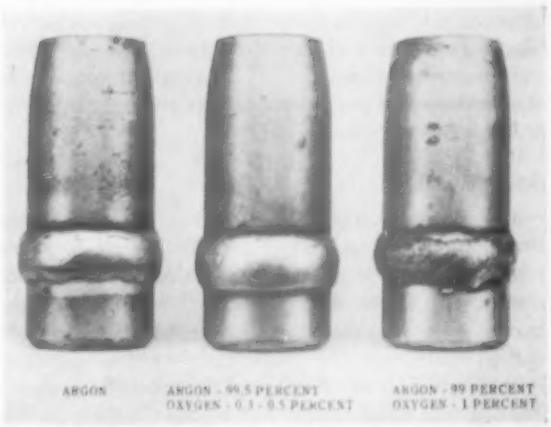


Fig 6 Effect of argon and argon-oxygen mixtures on copper overlays

but at least 98% copper. All other commercially available copper wires have been evaluated and found to be inferior as electrode material for this application. The most acceptable material, however, is not considered the ultimate, and investigations are being made of other alloys which are essentially all copper.

Copper overlays were applied, in many instances, with a gas shield of pure argon. The addition of approximately 0.3 to 0.5% oxygen to the argon, however, provided a more stable arc, minimized spatter and produced a sound and uniform bead, as shown in Fig. 6. The spatter from copper and copper alloys was much less than that from iron. The welding-head nozzles were polished, however, and periodically coated with a thin film of grease.

Silicon Bronze. Satisfactory rotating bands were made with welded overlays of silicon bronze containing 3% silicon. These bands, in the as-welded and machined condition, functioned satisfactorily in firing tests. They were not suitable, however, if it were necessary to heat treat after welding because of very adverse effects on the band. The hardness of these silicon bronze overlays was about R_B 40–45. A small

amount of oxygen in the argon provided the same advantages as with copper.

Aluminum Bronzes. Welded rotating bands were also derived from overlays of the iron-free 5 and 9% aluminum bronzes. The latter had an overlay hardness of about R_B 70. These overlays were safely heat treated after welding when desired. Application of the 9% alloy was improved in some instances by the addition of 0.5% oxygen to the argon. The 5% alloy, however, responded best with a shield of pure argon.

Gilding Metal. One of the materials commonly used for conventional rotating bands is "gilding metal," which, in ordnance, is an alloy of 90% copper and 10% zinc. It was desirable, of course, to try to duplicate this composition in a welded overlay band. This imposed problems, however, since a copper-zinc alloy electrode loses much of its zinc in the welding arc. Also, the fumes from vaporized zinc may be very annoying and sickening. A satisfactory method was found, however, for applying overlays of gilding metal. A copper electrode was employed along with an 80/20 copper-zinc alloy cold wire. The 90/10 copper-zinc alloy was formed in the weld puddle and very little loss or fuming of zinc was encountered.

Base Metal

Many types of steels have been used for the projectiles which have been overlayed. These include low- and medium-carbon steels, leaded medium-carbon steel, resulfurized free-cutting steels of low- and medium-carbon content, and high-alloy steels with quite high-carbon contents. The projectiles ranged in size from caliber 0.50 ($^1/_2$ in. diam) to 280 mm (11 in. diam). Most of the development has been with shell (hollow projectiles) although welded rotating bands have been applied to some shot (solid projectiles). The process is more adaptable to shell since they are readily cooled, if necessary, by internal jets of air or water. Only hollow projectiles have been in production with welded overlay rotating bands.

The standard artillery heavy-walled shell are usually shaped by hot forging and are commonly made of SAE 1050 steel. The shell are heat treated to either 65,000 or 85,000 psi yield strength, depending upon the application. During development, over 15,000 of such shell have been overlayed in the heat-treated and finish machined condition. The mechanical properties of the wall beneath the overlay were maintained within specification limits. Cooling was gradually diminished and finally discontinued, in many cases, as the welding procedures were improved.

In shell formed by cold extrusion, the strength required in the side wall is usually obtained by cold working the steel. Before specifying welded overlay rotating bands, it was necessary to allay concern regarding any detrimental effects of the welding heat on the mechanical properties of the base metal. A series of tests was conducted on the 75-mm cold extruded shell in order to determine if welded bands were feasible.

The heat-affected zone caused by overlaying a copper alloy on the cold extruded shell did not exceed the depth required for the conventional band seat. It was found, also, that there was no significant difference between the strength of the metal beneath the conventional band seat and that of the same region of the overlayed shell, as normally checked for specification purposes. Furthermore, the over-all strength of the side wall was significantly greater for shell with overlayed rotating bands. It was concluded, therefore, that shell with welded overlay bands had definite advantages.

The welded copper overlay rotating band has been accepted for the 30-mm HE (high explosive) shell and has been used extensively on the thick-walled practice shell. Various types of steel have been used for these development items. Practice shell are inert-loaded and have no critical strength requirements. They have been machined from SAE 1117 and 1137 resulfurized steel bar stock. The thin-walled HE shell have been made in large quantities by machining from SAE 4140 and SAE 1041 leaded steel. An SAE 1035 steel has been employed in the development of a cold extruded shell. Welded copper overlays have been applied to all of these steels. There were differences in the intergranular penetration of copper and in the appearance of micro-cracks which followed the grain boundaries. Although these did not affect the normal functioning, extensive tests were initiated to determine the reasons for inconsistencies and to attempt to eliminate or to minimize this micro-cracking.

Welded copper overlay bands have been affectively used in developing medium-carbon and high-alloy steel shot. It was necessary, at first, to cool these projectiles by immersing the lower one-third in a trough of running water during the welding. Cooling was discontinued at a later date. All of the shot were heat-treated after welding.

Those projectiles which are normally heat-treated should be given the treatment after welding, since the heat-affected zone is erased and residual stresses resulting from welding are relieved. It was necessary, however, in this development to use shell which were heat treated and finish machined. The heat-affected zone caused by welding was not detrimental to these or other projectiles tested in the as-welded condition.

Ballistic Considerations

The application of overlays for rotating bands introduced variables and features that had not been associated with conventional banding. Consequently, band design and ballistic studies were essential to the development and these paralleled the welding activities.

A principal deterrent in the use of welded bands for projectiles has been the fear of increased gun wear due to higher band pressures (radial pressures exerted on barrel). The elimination of the band seat in the overlay application reduced the amount of soft material available for cushioning. Consequently, the band pressure would be expected to increase for a given material and design.

This characteristic was noted in a push test which

consisted of forcing the projectile through a portion of a gun barrel containing the forcing cone. When using the 75-mm T50 shell with the conventional band design, it was found that the welded gilding metal band produced somewhat higher radial band pressures during the first 3 in. of travel than did the conventional gilding metal band. Higher pressures also occurred with overlayed 5 and 9% aluminum bronzes, silicon bronze and iron. The highest band pressures were observed with the 9% aluminum bronze. It was noted, however, that the band pressures recorded for welded copper overlayed bands were equivalent to the pressures obtained with the conventional bands even though no band seat was used for the welded bands. This was a definite indication, therefore, that welded copper bands without seats could be directly substituted for the conventional band in many applications.

In a number of different types of shells, there is more band material beneath the gun land than is considered necessary to permit the lowest band pressures consistent with the shell and gun design. Although the band pressures with other overlay materials were somewhat higher than with the "swaged in" band, it is quite possible that equivalent band pressures could be obtained with these materials, if they were overlayed in a shallow seat. The depth of the seat would vary, depending on the material. The machining of such a seat would not be so extensive or costly as that of the deep knurled seat needed for conventional bands.

In certain instances, an alternate or supplementary method for promoting lower band pressures would be to redesign the band contour. The influence of modified band designs, which included canneluring (relief grooves), was observed during initial work with welded iron bands.

Performance of Welded Ferrous Bands

Band Design

In early applications of welded iron on 105-mm shell, the overlays were quite hard (approximately R_B 85 to 90). Static engraving tests (push tests) not only indicated that softer deposits were necessary, but that the conventional band which contained no cannelures (relief grooves) should be redesigned to satisfy the new material and process. Several modified contours were evaluated in subsequent firing tests. It was found that two cannelures reduced the radial pressure exerted on the interior of the barrel to an amount comparable to that experienced with swaged gilding metal bands. The ballistic performance of the test rounds was satisfactory. As the result of improved welding techniques and annealing, which were previously discussed, the hardness of these bands was approximately R_B 70 to 72.

Gun Erosion

A two-cannelure design developed in studies previously mentioned was selected for a 10,000 round test to establish the influence of welded ferrous bands on gun wear. The experimental rounds were fired at a rapid rate through a gun tube that was new and stabilized at the beginning of the test. For control purposes, an equal number of standard rounds was fired simultaneously in a similar gun tube.

After firing 5000 each of the experimental and control rounds, the tube which had fired the projectiles with ferrous bands showed slightly greater wear near the forcing cone. The wear patterns for both tubes, however, were similar.

As the test continued, a marked increase in the rate of gun wear occurred with welded iron bands. This was particularly noticeable immediately forward of the commencement of rifling (approximately 24 in. from the breech face). The wear produced by the welded iron band became less severe further along the tube and from 35 in. from the breech face forward, there was little or no difference between the two tubes.

Unlike the 5000 rounds in the first part of the test, the welded iron bands for the second half of the test were painted. An intermediate test of several hundred rounds had shown no indication that paint would influence the performance of the rounds. Therefore, the welded ferrous bands were painted to eliminate the usual masking operation and to prevent any possible corrosion during shipping and storage. It is possible, however, that the paint may have been a contributing factor in accelerating the wear during the second half of the erosion test. This change was unfortunate in view of the results.

The welded ferrous bands, as prepared for the wear test, were considered more abrasive than gilding metal bands. It was reported, however, that the gun wear experienced from welded ferrous bands did not affect the accuracy of these rounds.

It is believed that peak performance was not obtained with the ferrous bands. Recent studies with the a-c series arc technique, using emissive-coated electrodes and aluminum-coated auxiliary wires, provided ferrous overlays appreciably softer than any which have been fired. This improvement could readily ease gun wear.

Fragmentation

Several 105-mm HE shell equipped with overlayed and annealed ferrous bands were subjected to fragmentation tests. The tests were advisable since it was not known whether the heterogeneous structure of the shell wall due to overlay annealing would affect the size distribution and quantity of fragmented particles. The shell were exploded in sand by electrical ignition and the particles removed by mechanical sifting.

This test disclosed that the band material did not separate from the shell wall as is experienced with conventional gilding metal bands. Although this slightly reduced the number of fragments, it was not considered detrimental. No other differentiating features were noted.

Band Porosity

Prior to the introduction of an aluminum-coated cold wire to the molten puddle, porosity frequently occurred in the ferrous overlays. In view of this porosity, a small firing test was conducted with 90-mm shell to determine the effect of band porosity. Ferrous overlays were machined to a five-cannelure design and

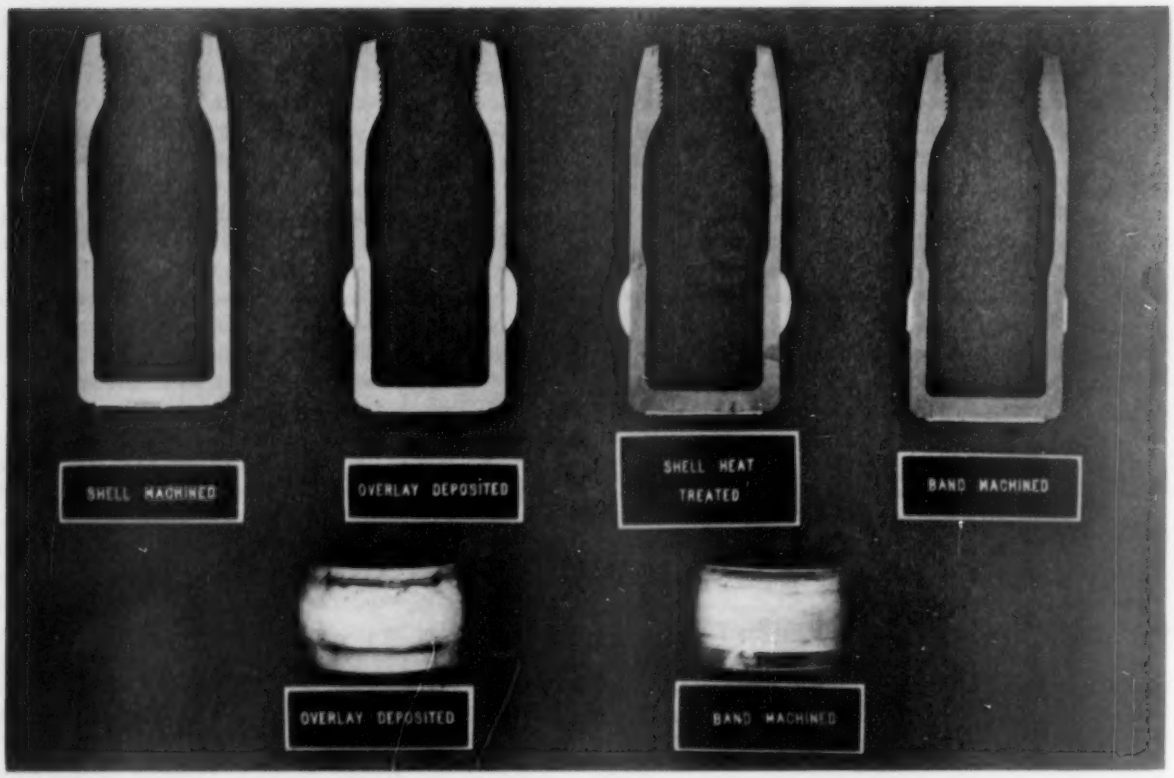


Fig. 7 Welded copper overlay rotating band on 30 mm HE thin-walled shell

graded into three groups of ten each from good to extremely porous. This band contour was selected because it was believed to be more sensitive to any porous region.

The shell were randomized and fired. Standard rounds were included in the test for control purposes. The performance of the test rounds was considered satisfactory. A statistical analysis of the firing data showed no significant difference between porous and nonporous bands.

Performance of Welded Nonferrous Bands

The 105-mm shell continued to be used extensively during the investigation of nonferrous overlayed bands. A firing test was conducted to evaluate the performance of the various copper base materials being explored for overlay band applications. Several hundred rounds equipped with welded copper, silicon bronze and aluminum bronze bands were fired in new and worn gun tubes. Shell with bands of each material were fired as a group. Standard rounds were fired before and after each experimental group for comparison.

The recorded data, including velocity, chamber pressure, range and deflection, were statistically treated. There was no significant difference observed in any phase of the test between overlayed materials and swaged gilding metal. The velocity spread of all test rounds fell within the range of the control rounds. Strain data also were recorded for the tubes but, unfortunately, this information could not be satisfactorily reduced to radial band pressures.

Application

Ordnance Acceptance

There has been increasing interest in and acceptance of welded overlay rotating bands for ordnance ammunition during the past year. The welded copper band is required or listed as an alternate for at least six different experimental shells and rocket motor bodies. Several of these components, particularly 30-mm thin-walled (Fig. 7) and heavy-walled shells, are being made in large numbers by industrial manufacturers. Extensive firing tests have been conducted with production lots of 30-mm shell to investigate various aspects of the weapon. It is understood that the functioning of the overlayed band is satisfactory and that no band problem exists, if proper welding conditions are maintained.

The other components being manufactured with welded copper bands include two types of thin-walled artillery projectiles and 70-mm and 2.75-in. rockets, all of which are currently experimental.

Acceptance of Copper

The use of copper for these items was a normal step in the transition from conventional banding practices to overlaying. Although several of the aforementioned projectiles may not have reached their present stage of development without incorporating the welded band,

it would have been premature to immediately accept a banding material that had been heretofore unknown to banding technology. When the requirement for a welded band was established, the application of a gilding metal overlay had not been explored. Additional information was needed on the weldability and performance of the bronzes, and the use of iron was deferred because of its questionable effect on gun life. The weldability of copper, however, had been reasonably established. Copper was an accepted material for conventional banding applications in Naval Ordnance and appeared to be the most likely substitute for gilding metal wherever an immediate need for welded bands existed. A severe reduction in gun life was believed to be remote in view of the ductility and the low hardness of the copper deposit.

For these reasons, copper was also used in preliminary feasibility studies conducted at the Frankford Arsenal. A typical example was the application of welded copper bourrelets to 4.5-in. rocket motor bodies. These bourrelets centered the rocket in the bore while traveling through the launcher and were not intended to serve as rotating bands. The investigation demonstrated what might be done with welded overlays on thin tubular steel without serious distortion or degradation of properties.

Similar studies were conducted using copper with 280-mm test slugs and 20- and 120-mm shot.

New Developments

New possibilities for welded bands have continually developed. One type of 20-mm shot recently presented an interesting application for overlay banding. This projectile, equipped with a conventional band, has an adapter or sleeve around its forward section, which is mechanically bonded to the shot body by forcing it over the knurled surface of the shot. Malfunctioning has been experienced with this shot because of failure of the adaptor to maintain its proper orientation with the shot body during loading operations. A feasibility study was conducted to determine the applicability of a welded copper overlay band. The projectile was redesigned so that the overlay would serve the dual purpose of attaching the adaptor to the shot body and providing material for a rotating band as shown in Fig. 8. The results of tests showed that projectiles equipped with overlays had a greater bonding strength between the adaptor and the shot body than the conventional projectiles. Furthermore, the advantages of an overlay band would be realized.

A program has been initiated for the development of welded bands for several types of 20-mm shells. Flyoff has been experienced with the conventional bands on these projectiles. Since this separation has not occurred with welded bands, this method of fabrication would be the ideal solution. The program will include a study of copper and 5 and 9% aluminum bronze for overlay bands. Welding techniques will be developed and the need for or desirability of heat treating after welding will be investigated. Firing tests for ballistic performance and gun wear are planned which should indicate the most suitable band material for the shells.

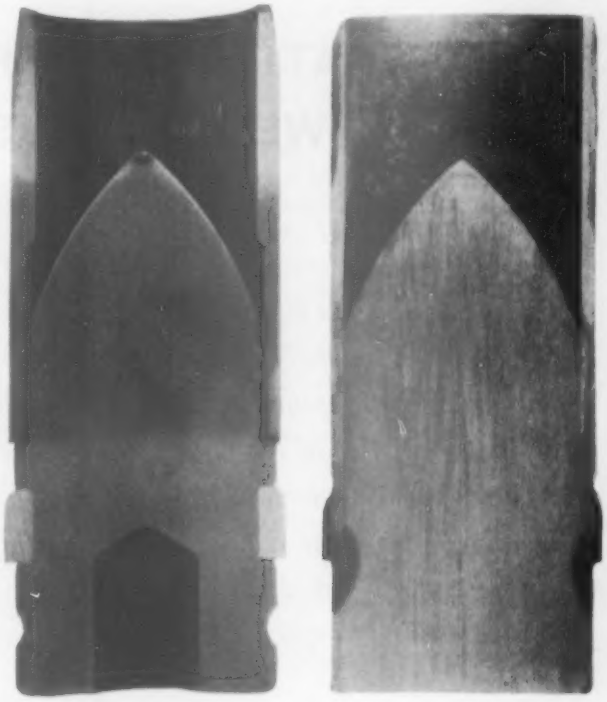


Fig. 8 Sections of 20-mm projectiles with sleeve adapters illustrating advantages of welded overlay process

Acknowledgments

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COMPARATIVE PROPERTIES OF ELECTRODES FOR ARC WELDING AUSTENITIC MANGANESE STEELS

Comparative tests show that there are significant quantitative differences in the properties of four basic types of materials commonly used for the fabrication or build-up of austenitic manganese steels

BY
W. L. LUTES AND H. F. REID, JR.

Wear-life of earth-moving equipment can be extended greatly by the application of arc welding

SUMMARY. Four basic types embracing seven grades of commercial materials recommended for fabrication or build up of a base for hard-surfacing overlays on austenitic-manganese steel were tested and found to be less interchangeable than indicated by normal field usage. Each type of weld metal had specific advantages and limitations. Variations in properties of the individual deposits suggested the need for greater care in selecting the best alloy for a specific application.

Best results were obtained using weld metal deposited by the chromium-manganese or the composite nickel-manganese electrode. The inherent strength and toughness of these deposits suggested that either of these two electrodes might be used for both the fabrication and surfacing of manganese steel.

Weld metal deposited by the chromium-nickel electrodes had initial hardness, yield strength and ultimate tensile strength second only to those of the chromium-manganese deposit.

In general, weld metal deposited by tubular-type nickel- or molybdenum-manganese electrodes had the same general properties as electrodes employing the corresponding modified Hadfield manganese steel as the core wire.

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Introduction

The use of austenitic manganese steels has increased steadily since their discovery by Robert Hadfield late in the 19th Century. Today, austenitic manganese steel has earned the reputation of being a "cure-all" for applications where punished parts represent an industrial wear problem. Inherent toughness, work hardening characteristics and excellent resistance to some types of abrasive wear combine to make austenitic manganese steels truly one of the toughest steels known.

Welded fabrication and reclamation have been important factors in the increased use of austenitic manganese steels. A number of different types of welding alloys have been developed to fabricate and build up austenitic manganese steels. These alloys differ widely with respect to chemical composition, mechanical properties and initial purchase price. At times, considerable confusion has been caused by the apparently wide differences in the properties and chemical analysis of such materials recommended for the same application.

This article describes briefly the general characteristics of the various types of work-hardening austenitic materials used for fabrication and build up of austenitic manganese steels. The physical and mechanical properties of weld metal deposited by typical commercial welding electrodes in each of the various categories are compared.

General Description of the Alloys Tested

Seven examples of four basic types of commercial materials recommended for the fabrication or surfacing of austenitic manganese steels were selected for this study. Composition of the various alloys are summarized in Table 1. Throughout the remainder of the text, these alloys will be referred to by number or by reference to the primary alloys.

A detailed discussion of metallurgical structure or of the specific mechanism of work-hardening of these various alloys is beyond the scope and intent of this paper. All of the deposits referred to in subsequent paragraphs, however, are essentially austenitic in structure and work harden in service.

The four types tested may be divided into two groups based on the chromium content of the weld deposit. The chromium-bearing group is composed of a chromium-manganese and a chromium-nickel deposit, Compositions 3 and 4, respectively. The chromium-free materials, Compositions 1-A to 2-B, are modified Hadfield manganese alloys in which either nickel or molybdenum is used as the modifying agent. The alloy content of the deposit may be supplied by an alloy-steel electrode core wire, an alloy-filled tubular core wire or an alloy-enriched electrode coating.

In addition to coated alloy wires, composite and tubular electrodes were included in the study because of the possibility of variations in the properties of the weld deposit. Such variations were not believed the direct result of differences in the method of manufacturing, *per se*. They probably reflected differences in composition and alloy balance of the individual weld deposit as established by the various manufacturers.

Chromium-Nickel Weld Deposit—Composition 4

Modified Type 308 weld metals containing increased carbon and manganese contents were developed for the surfacing of manganese steels about 1948.[1] Since their introduction less than ten years ago, the popularity of Composition 4 type materials has grown steadily.

The over-all advantages of Composition 4 are related directly to mechanical properties of the deposit and will be discussed in detail in subsequent sections of this article.

The disadvantages of Composition 4 are predominantly economic. The initial cost of the alloy generally is somewhat higher than that of reportedly comparable modified Hadfield manganese deposits. Therefore, to be economically attractive for any given application, this higher initial cost must be offset by additional savings. Such savings would have to be the direct result of longer service life, decreased down time or a higher reliability factor. In some applications, inability to cut or gouge the deposit with an oxyacetylene torch constitutes a disadvantage. Composition 4 must be cut or shaped by grinding.

Chromium-Manganese Weld Deposit—Composition 3

Austenitic chromium-manganese stainless steel, Composition 3, is the newest material to be recommended for the surfacing of 12–14% manganese steels. This weld deposit is a patented[2] modification of the low-nickel content stainless steels introduced in the United States during the period of nickel shortage of 1952–53. At that time, high-manganese stainless steels were sold under several trade designations. These steels reportedly had properties equivalent in many respects to those of Type 302 and Type 304 materials. A large portion of the nickel content of the conventional stainless steel was replaced by manganese. Replacement was made on the basis of approximately two percent of manganese for each percent of nickel displaced.

Carbon content of Composition 3 was appreciably higher than that of high-manganese sheet or plate materials. Small amounts of molybdenum and vanadium were added to the weld metal to improve the over-all properties.

Composition 3 had an outstanding advantage over other materials normally used for welding on 12–14% manganese steels. This new type of electrodes was recommended for either joining or build-up applications. Generally, no intermediate layer of conventional stainless steel weld metal was necessary to insure good crack-free fusion with the base material. The deposit reportedly provided an unusual combination of high yield strength, ductility and crack resistance.

The disadvantages of Composition 3 are similar to those of Composition 4. The initial cost is approximately the same as that of Composition 4 and the weld deposit cannot be flame cut or gouged successfully.

Table I—Materials Tested

Composition No.	*General type*	*Analysis of weld deposit, %*							
		Carbon	*Chromium*	*Manganese*	*Molybdenum*	*Nickel*	*Phosphorus*	*Silicon*	*Vanadium*
1A	Composite nickel-manganese	0.75	0.38	14.5	..	3.46	0.021	0.65	..
1B	Nickel-manganese (alloy wire)	0.60	0.38	12.5	..	3.55	0.049	0.70	..
1C	Nickel-manganese (tubular type)	0.58	0.41	11.6	..	3.24	0.053	0.43	..
2A	Molybdenum-manganese (alloy wire)	0.41	0.11	12.3	1.02	..	0.049	0.71	..
2B	Molybdenum-manganese (tubular type)	0.36	0.12	11.9	1.12	..	0.055	0.35	..
3	Chromium-manganese	0.35	14.5	14.1	1.65	1.05	0.026	0.62	0.62
4	Chromium-nickel	0.70	18.6	3.90	..	10.4	0.027	0.75	..

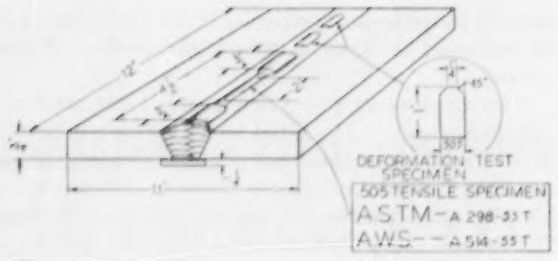
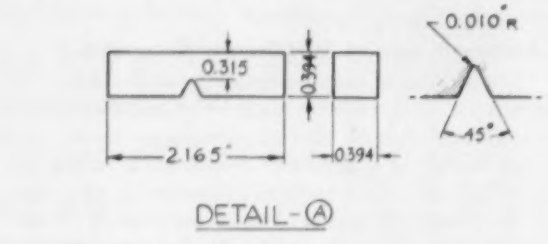


Fig. 1 Preparation of tensile and plastic deformation specimens



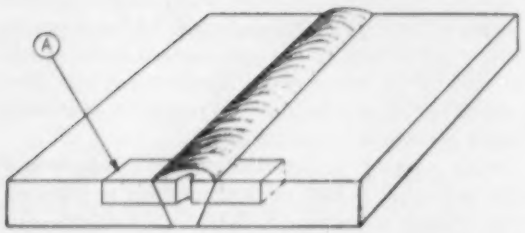


Fig. 2 Preparation of ASTM Charpy V-notch impact specimens

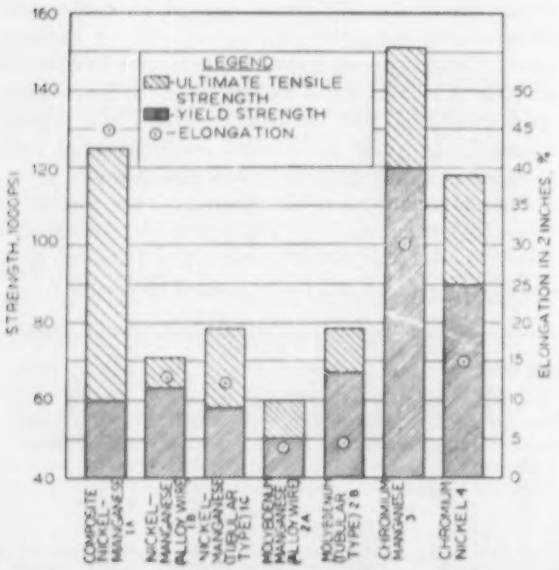


Fig. 3 Mechanical properties of all-weld-metal tensile specimens

Nickel-Manganese Weld Deposits—Compositions 1A, 1B and 1C

The introduction of nickel-manganese electrodes in the late 1920's provided the first important impetus to the development of the mass welding of manganese steels. The most important role of the nickel addition was to maintain the tensile strength of manganese steel in which the carbon content was lowered to avoid carbide-precipitation-embrittlement.[3] Throughout the years, bare and coated nickel-manganese electrodes have been the major electrodes used to join or build up worn manganese steel parts. Bare nickel-manganese electrodes currently are available either as drawn wire or as tubular material. Coated nickel-manganese electrodes may be coated alloy wire, coated tubular material or composite electrodes, Compositions 1B, 1C or 1A, respectively.

Deposits of this type provide tough, wear-resistant surfaces at minimum initial material cost with Compositions 1A and 1C offering the greatest economic advantages. The over-all mechanical properties of a nickel-manganese deposit have proved to be adequate for many applications. Deposits of this type may be cut or shaped with an oxyacetylene torch.

The disadvantages of a nickel-manganese type deposit are related directly to the mechanical properties of the deposit, and will be discussed in detail in subsequent paragraphs.

Molybdenum-Manganese Weld Deposits—Compositions 2A and 2B

The molybdenum-manganese alloy was introduced during the nickel shortage days of World War II as a substitute for the nickel-manganese material. Experience showed that 1% of molybdenum could be substituted successfully for the nickel content of the nickel-manganese alloy. The mechanical properties of the resulting alloy were equal, if not slightly superior, to those of nickel-manganese material of the same carbon content. Molybdenum-manganese electrodes, Compositions 2A and 2B, now are available in most of the same forms as the nickel-manganese electrodes.

Color match was a distinctive advantage of the molybdenum alloy. Other types of weld metal frequently developed lusters that were more reflective than the base metal. Under similar conditions, repairs made with molybdenum-manganese materials matched the color of the base material and passed unnoticed. Compositions 2A and 2B cost about the same as their nickel-manganese counterparts and may be flame-cut successfully.

Other advantages and disadvantages of the molybdenum-manganese deposited will be pointed out in the comparison of the mechanical properties of the various types of deposit.

Experimental Work

Tests were conducted to determine the properties of weld metal deposited by seven commercial materials recommended for use with 12–14% manganese steels. These tests included conventional tests for measuring

ultimate tensile strength, ductility and impact strength. Special tests were employed to evaluate the general susceptibility of the individual alloys to cracking and to plastic deformation under impact.

Welded or all-weld-metal specimens were used in these tests instead of cast specimens employed by many previous investigators. Bulk of data published on materials of this type utilized cast specimens as a means of limiting the number of potential variables and of obtaining basic information on the properties of the individual alloys. It was felt that welded and all-weld-metal specimens would provide data related more closely to normal consumer usage of materials of this type.

Preparation of Test Specimens

All-weld-metal tensile specimens were prepared from the groove welds as shown in Fig. 1. The beveled edge of each plate was overlayed with a single layer of the material to be tested prior to assembly. Portions of the groove weld were machined to make the special specimens used to evaluate work-hardening and plastic deformation characteristics. Charpy (V-notch) impact specimens were cut transverse to the direction of welding as shown in Fig. 2.

All welds, except those made using Composition 2A, were made in the downhand position without the use of special welding techniques. In this latter case, best results were obtained by welding vertically-up with the assembly inclined about 30 deg from the perpendicular. Under these conditions, the shelf-welding technique employing a long arc and large weld pool proved the most satisfactory.

All welds were made using $^{3}/_{16}$-in. commercial electrodes and reverse polarity, direct current. Welding amperage was adjusted to provide optimum operating conditions for each type of electrode. All groove welds were made under conditions as outlined in AWS Specification A298–55T.

Mechanical Properties

The results of testing a series of all-weld-metal tensile specimens are summarized in Fig. 3.

The chromium-manganese deposit, Composition 3, proved the strongest material tested. In general, weld metal deposited by the chromium-bearing alloys had higher yield and ultimate tensile strengths than those of the chromium-free deposits. The composite nickel-manganese deposit, Composition 1A, was the exception to this general observation. The tensile strength of this latter material was of the same general magnitude as that of the chromium-bearing alloys and more than 50% higher than the tensile strength of any other of the chromium-free weld deposits tested. Ductility of the weld metal was appreciably greater than that of any other of the materials tested. These properties of Composition 1A compared favorably with those of nickel-manganese castings after toughening and selective heat treatment.[4]

The yield and tensile strength of the remaining four alloys tested were very similar with the ductility of the nickel-manganese deposits a little greater than that of the molybdenum-manganese materials. Properties of weld metal deposited by the tubular electrodes were somewhat superior to those of weld metal deposited by electrodes employing alloy core wire.

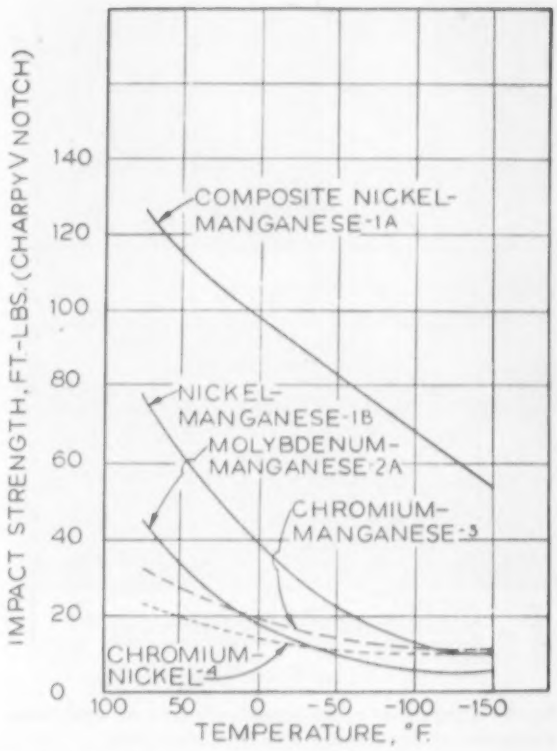


Fig. 4 Charpy impact test values

Impact Strength

Impact strength and transition temperature of materials for the welding of 12–14% manganese steel may have limited application. At the same time, however, such information does have practical significance. Many open pit mines operate at zero and subzero temperatures. Marked differences in impact strength of weld deposits used under such conditions could have a vital influence on the service life of the equipment.

A series of Charpy (V-notch) impact specimens was prepared from weld metal deposited by five of the seven types of electrodes, Fig. 4. As in the case of the all-weld-metal tensile specimens, considerable difficulty was encountered in producing satisfactory specimens from Composition 2A. A limited number of tests also were made to compare the impact strength of weld metal deposited by the tubular type of electrodes with that of weld metal deposited by the alloy-wire type, Fig. 5.

Best results were obtained using Composition 1A. At −150° F, the impact strength of these specimens still was greater than that of the bulk of the other specimens at any of the testing temperatures. Composition 1B also seemed more resistant to impact than the bulk of the materials tested. For some undetermined reason,

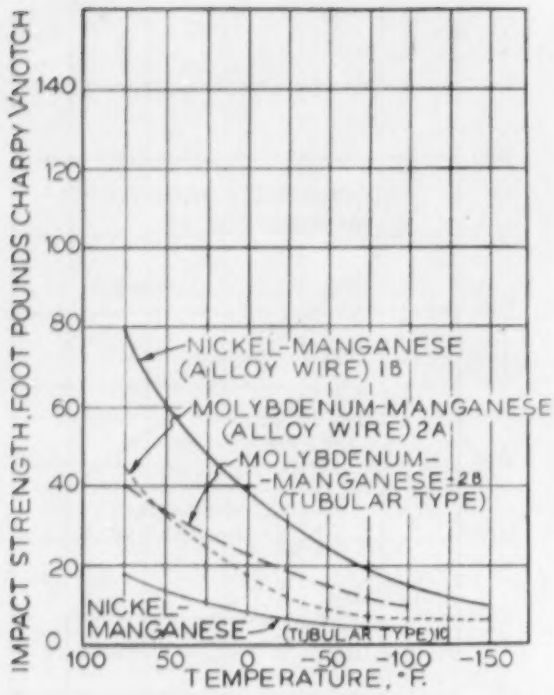
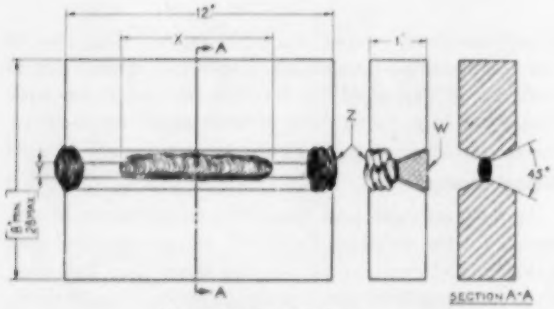


Fig. 5 Comparison of the impact resistance of weld metal deposited tubular vs. alloy wire type electrodes



STANDARD CONDITIONS

ELECTRODE SIZE, INCHES	WELDING CURRENT, AMPS.	Y INCH	X INCH	LENGTH OF ELECTRODE CONSUMED, INCHES
5/32 x 14	145	1/8	3	12 1/2
5/32 x 14	185	1/4	4 1/2	12 1/2
1/4 x 14	245	3/8	4 1/2	12
1/4 x 18	245	3/8	5 1/2	14

Fig. 6 Schematic view of crack test

the impact strength of Composition 1B was considerably greater than that of the Composition 1C, although the materials were of the same general analysis. In view of the limited number of tests of weld metal deposited by tubular electrodes, additional testing will be necessary to explain this difference.

With the exception of Compositions 1A and 1B, there was little to choose between the impact strength of the remainder of the welded specimens. All had a strength of about 15–20 ft-lb at zero with the values dropping off to 5–10 ft-lb at −100° F.

Crack Resistance

Crack resistance of an alloy is a property that is difficult to define and equally difficult to measure. The general term may have a multitude of definitions. Tests for cracking have not been standardized to the point where results are accepted and understood as in the case of a hardness reading. A number of cracking tests have been developed and used for specific studies.

The crack test used for this study originally was developed at The McKay Company for use as a quality control test for individual lots of armor-welding electrodes. A modified version of the control test later was adopted as a standard requirement for qualification of armor welding electrodes.[5] The test proved so sensitive to minor variations in composition of the weld deposit that its use was extended to more general studies of weld metal and weld metal cracking.

The test, shown schematically in Fig. 6, consists of a thin layer of weld metal deposited under rigidly controlled conditions in a restrained double V joint. The relative crack resistance of an alloy is estimated by the percent of the total length of the weld that does not crack. Figure 7 shows a cutaway view of the test assembly and typical test specimen.

The seven weld metals being evaluated were subjected to this crack test with typical results as shown in Fig. 8. Compositions 1A and 3 deposits were crack-free. The crack resistance of these deposits was rated equal to that of welds made under similar conditions using armor-welding electrodes or some of the more crack-resistant grades of stainless-steel electrodes, Type 312 or Type 349. Welds made using each of the

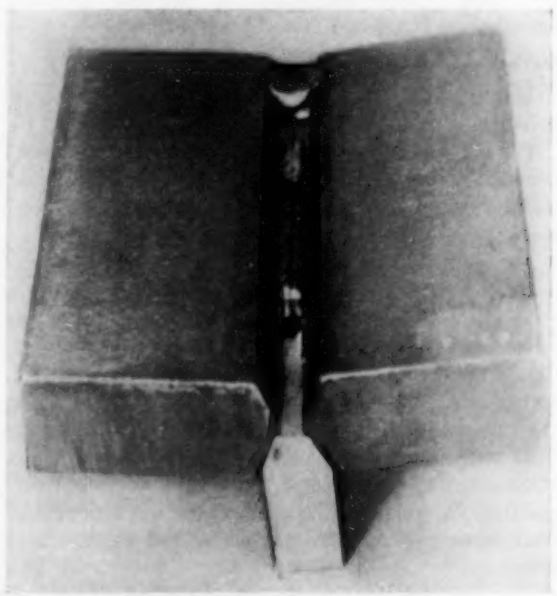


Fig. 7 Cutaway view of crack test

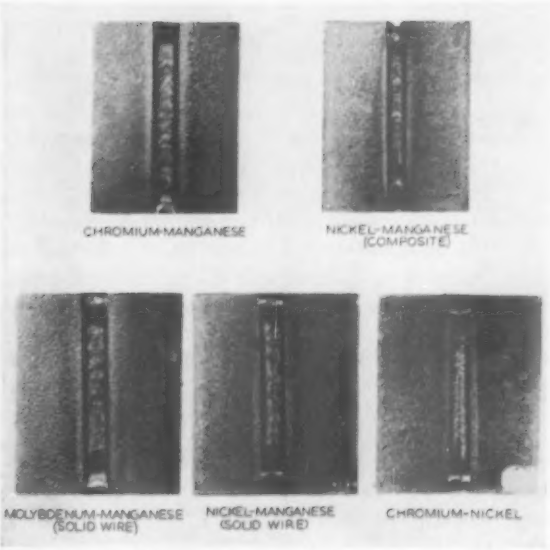


Fig. 8 Typical crack resistances

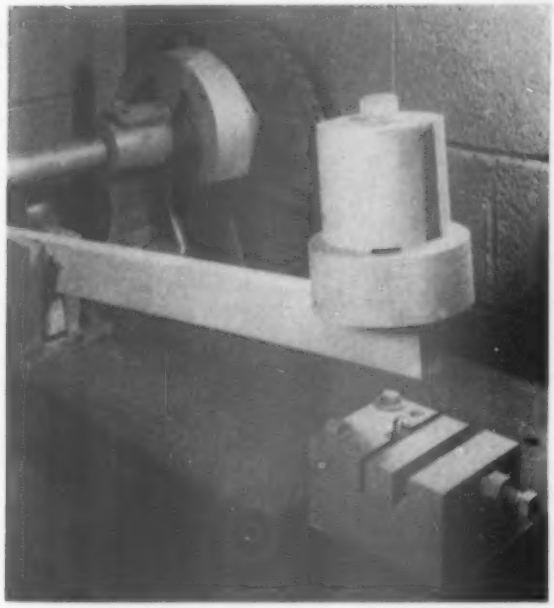


Fig. 9 Impact testing equipment

other electrodes being evaluated cracked almost the entire length of the deposit. On this basis, this latter group of five commercial electrodes would not be recommended for high-stress applications such as the welding of dissimilar metals or the fabrication of heavy sections.

Work Hardening and Plastic Deformation

Ability to work harden and, at the same time, resist excessive plastic deformation are two of the most important properties of any material for the welding of 12–14% manganese steel. Such steel and weld deposits must be capable of work hardening on the surface and yet retain a resilient, impact-resistant structure throughout the mass of the material. Work hardening results from plastic deformation of the surface under the force of repeated impacts. It is desirable that surface hardening develop quickly without excessive deformation of the original shape of the deposit. The ideal material, therefore, would be one which would work harden rapidly on the surface and deform only slightly under the impacts needed to develop this hardness.

Work-hardening characteristics of the various alloys were evaluated using the cylindrical all-weld-metal specimen shown previously in Fig. 1. The specimen was mounted rigidly as shown in Fig. 9 so that the tip formed an anvil for a free-falling hammer. The tip of the all-weld-metal specimen was struck with a force of 25 ft-lb at a rate of 75 impacts per minute. Periodically, the calibrated specimen was removed from the equipment and the over-all length remeasured. The difference in length was taken as a measure of the amount of plastic flow occurring under the conditions and duration of testing.

Rate of work hardening was determined by plotting the hardness of the tip of the plastic-flow specimen as it

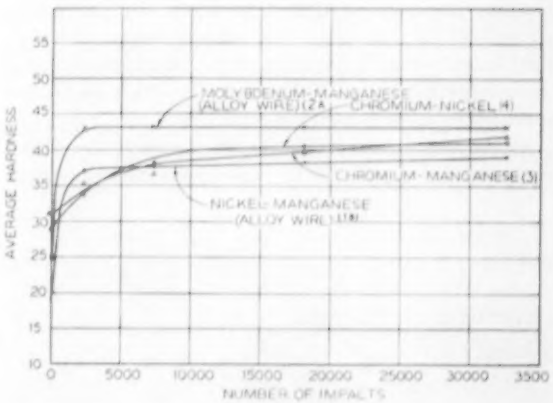


Fig. 10 Work-hardening characteristics

was subjected to an increasing number of impacts. The results of these tests are summarized in Table 2 and in Fig. 10.

In the as-welded condition, Compositions 3 and 4 had the highest hardness. Molybdenum-manganese deposits were slightly harder than their nickel-manganese counterparts. Composition 1A was the softest material tested.

After the first test period, 2500 impacts, the relative position of the four basic types of material in order of decreasing hardness was (1) molybdenum-manganese, (2) nickel-manganese and (3) chromium-manganese and chromium-nickel.

Hardness of weld metal deposited by Composition 2A electrodes rose rapidly to its maximum hardness and was unaffected by continued testing. There were no significant differences in the work hardening characteristics of Compositions 1A, 1B, 1C and 2B. They fol-

Table 2—Work-Hardening Characteristics

Composition No.	General type	Rapid determination: As deposited, Brinell	Rapid determination: Work hardened, Rc*	From deformation specimens: Initial hardness, Brinell†	From deformation specimens: After 32,500 impacts, Rc
1A	Composite nickel-manganese	140	32	231	41
1B	Nickel-manganese (alloy wire)	133	30	207	41
1C	Nickel-manganese (tubular type)	143	30	224	39
2A	Molybdenum-manganese (alloy wire)	179	40	265	44
2B	Molybdenum-manganese (tubular type)	174	41	255	43
3	Chromium-manganese	194	37	293	42
4	Chromium-nickel	168	30	277	41

* Measured at the center of the Brinell impression.

† Difference between these values and those in Column 1 probably reflect the extent of work hardening that occurred during machining. Values were converted from Rc readings.

lowed the pattern established by Composition 2A, although the values consistently were slightly lower.

The chromium-bearing alloys, Compositions 3 and 4, work hardened more slowly under the conditions of testing than either nickel-manganese or molybdenum-manganese deposits. After 7500 impacts, hardness of the chromium-bearing materials exceeded slightly hardness of the nickel-manganese deposits. The chromium-bearing materials continued to work harden slowly throughout the duration of this series of tests. In other, more extended tests, hardness of the chromium-bearing compositions exceeded 50 Rc after 100,000 impacts and appeared to be still rising slowly.

At the conclusion of the 32,500 impacts, the work-hardened tip of each of the specimens was examined metallographically to determine the effects on the structure of the individual alloys. There was a sharp difference between the structure of the chromium-bearing alloys and that of the chromium-free materials as shown in Fig. 11. Structure of the nickel- and molybdenum-manganese deposits were characteristics of structure normally associated with severely cold-worked material. In contrast, the chromium-manganese deposit showed only limited evidence of cold working. The lack of cold working and continued progressive hardening under prolonged testing of the chromium-bearing compositions suggest that the impact force of 25 ft-lb was not adequate to develop fully the work-hardening potentialities of the chromium-bearing materials.

The effects of repeated impacts on the length of all-

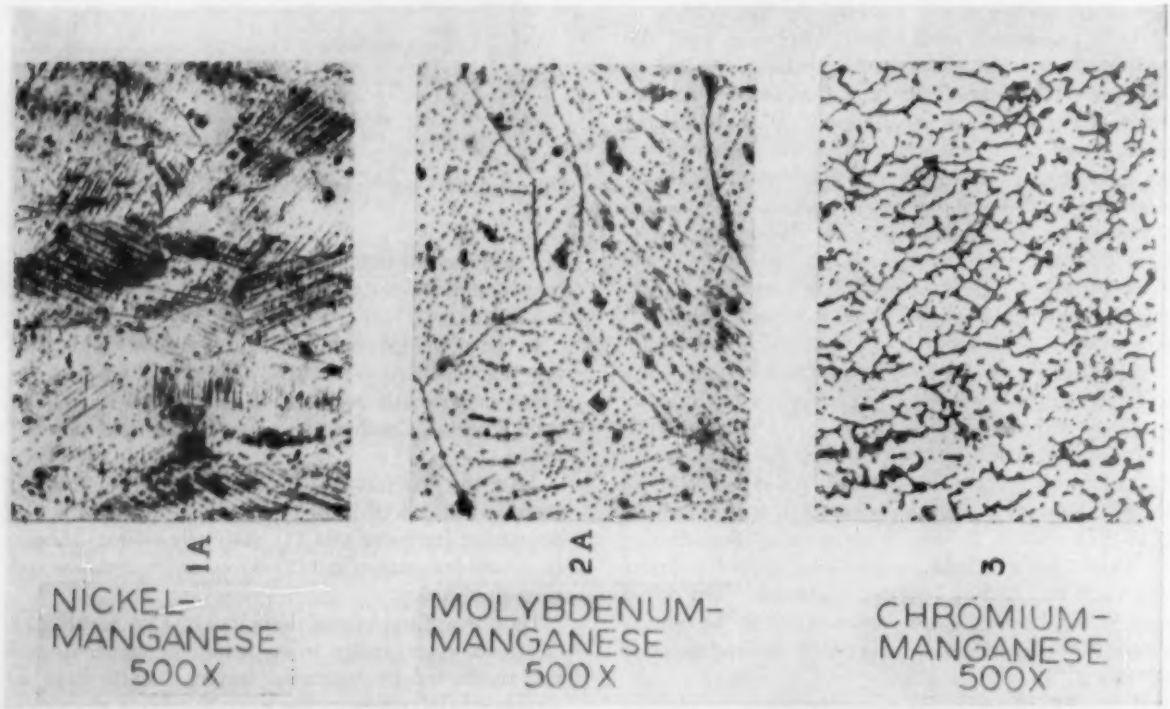


Fig. 11 Typical weld-metal structures after testing

weld-metal specimens are summarized in Fig. 12. The four basic types of weld metal differed markedly in the ability to resist plastic deformation under the test conditions. On the basis of decreasing resistance, the alloy types were rated in the following order: (1) chromium-manganese, (2) chromium-nickel, (3) molybdenum-manganese and (4) nickel-manganese.

The relative position of the various types of material in this list was identical to that obtained when the alloys were listed in the decreasing order of yield strength. High yield strength always was accompanied by low plastic deformation.

In all tests, 80 to 90% of the total deformation occurred during the initial minutes of testing, probably coincidental with the first sharp rise in hardness.

Discussion of Results

Results of this series of comparative tests emphasize a number of significant quantitative differences in the properties of four basic types of materials commonly used for the fabrication or build-up of austenitic manganese steels. The magnitude of these differences apparently are unappreciated by many as the materials are sold competitively and used interchangeably.

These results emphasize the need for additional published fundamental data on the relationship of chemical composition of weld deposits to the properties of the various types of material. This appears to be true particularly in the case of nickel-manganese and molybdenum-manganese weld deposits. Such study may be essential to determine if the present rather wide commercial ranges of chemical analyses for such materials are consistent with production of weld metal with the optimum combination of properties. Fundamental data may explain why the properties of Composition 1A, 1B and 1C weld metals are so drastically different despite the fact that all three are nickel-manganese materials. The same data may permit the development of molybdenum-manganese materials with greatly improved engineering properties.

These results also emphasize that as engineering data on these materials becomes available, there will be a pressing need for more intelligent selection of the best alloy for maximum service life in any given application. None of the materials tested is outstanding in every respect. Each type has advantages and disadvantages. Composition 3 comes the closest to fulfilling all the requirements for the ideal deposit. With all its advantages, the chromium-manganese alloy has minor defects which may assume major importance in a specific application.

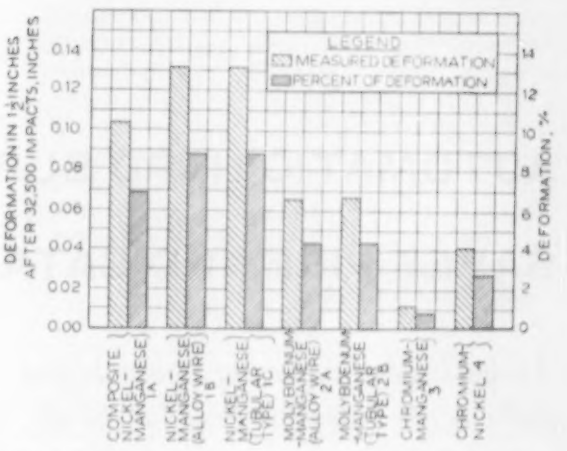


Fig. 12 Effect of repeated impact on length of test specimens

Based on these data, Composition 1A and 3 electrodes appear the best for general-purpose fabrication and build-up, because the weld deposit combined strength, ductility and crack resistance.

At zero and subzero temperatures, Composition 1A deposits are the preferred material.

If the application requires extremely fast work hardening, Composition 2A weld metal is recommended.

Where the abrasive wear is accompanied by heavy impact and plastic deformation of the section is a problem, Compositions 3 and 4 are recommended.

Acknowledgments

The authors wish to express their appreciation to The McKay Company for permission to publish these data, to the various members of the technical staff that assisted in the preparation of the test specimens, and to Dr. D. F. Helm for his assistance in preparation of the final manuscript.

References

1. U. S. Pat. 2,436,867 of Mar. 2, 1948.
2. U. S. Pat. 2,711,959 of June 28, 1955.
3. Avery, H. S., and Chopin, H. J., "Austenitic Manganese Welding Electrodes," The Welding Journal, 33 (5) 459-479 (1954).
4. "The Metallurgy of Welding Manganese Steel," Amsco Bulletin (Feb. 1949).
5. MIL Specification E-13080A.

AUTOMATIC HARD SURFACING SAVES PIPE AND CATALYST

Available hard-surfacing materials and methods are important tools for the oil refiner in his fight against erosion

BY R F. ARNOLDY

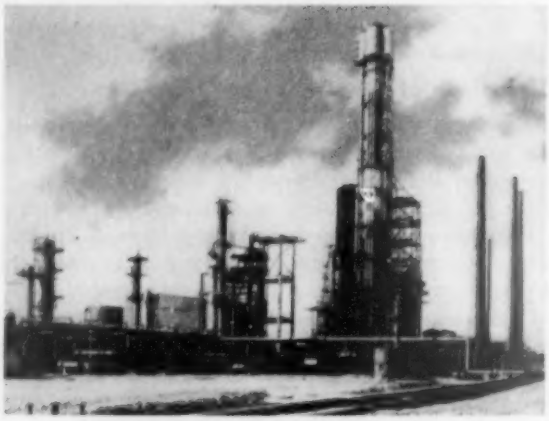


Fig. 1 Air-lift type moving-bead cracking unit

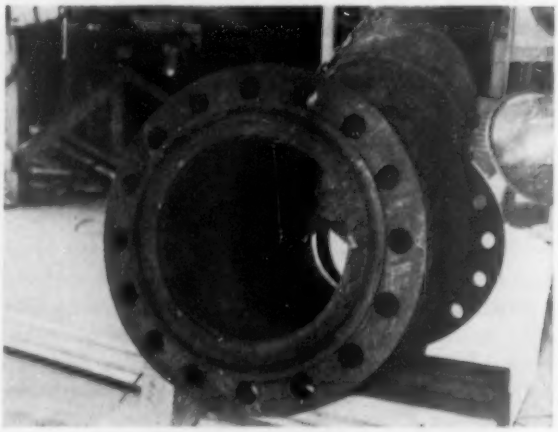


Fig. 2 Manual-arc-faced catalyst valve

Introduction

Automatic hard surfacing has found an important new field in the protection of refinery equipment against catalyst erosion. Properly used, it is also a significant means of reducing catalyst attrition and losses in unit efficiency.

The modern refinery makes wide use of catalyst in the production of a broad range of petroleum products and petrochemicals. A great portion of the catalytic type units employ the catalyst in a continuously moving bed or in fluid entrained particles. These often move at high velocities and are always at elevated temperatures. This cycling movement requires passage through reactor, kilns, piping, valves, introduction and separation equipment (see Fig. 1).

In character, this catalyst is usually a claylike substance in particles from dust-size up to pea-size pellets or beads. In motion and at the usual 1000° F area of temperature the impingement of this material on steel components causes erosion which tends to become selective and concentrated until failure occurs.

The attendant roughening and gouging of dead end grooves increase the rate of catalyst breakage. Such catalyst is lost and the resultant fines must be separated and continuously removed. Unit efficiency is lowered as fines concentration increases.

History

As these problems presented themselves in the use of moving catalyst units, various means were tried to lessen the destruction of equipment and catalyst. One of the earlier methods, used mainly in the fluid type unit, was a refractory mastic applied over a steel grating. Another, used mainly for air lift pipes in the moving-bead type unit, was a chrome iron centrifugally cast on the inside of a pipe.

Manual hard surfacing has long been used in protection of various components in moving catalyst units (see Fig. 2). These coatings gave outstanding performance using an appropriate choice of facing properly applied. The development of automatic hard

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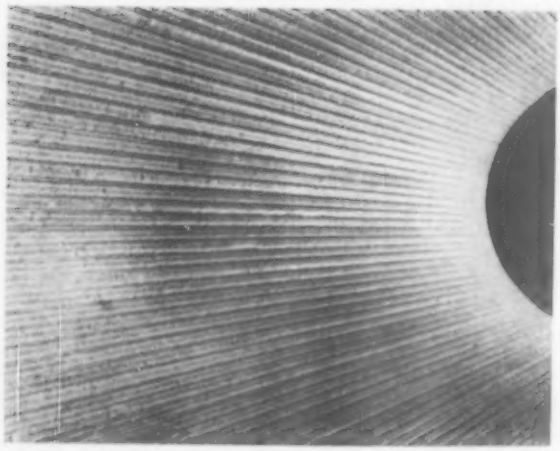


Fig. 3 Internal surface of 38-in. diam lift pipe as hard surfaced with submerged-arc automatic method

surfacing found a natural field in catalyst protection since the process was adapted to large areas, was low in area coated cost, and inherently produced smooth and uniform coatings.

Applications

Applications in this category are lift pipes, distribution piping, and a variety of internal parts too large in area for economical manual surfacing and favorable in section for automatic deposition.

One of the most important applications in this category is the lift pipe as used in the moving-bead unit (see Fig. 3). These range from 20 to about 40 inches in diameter and up to 200-plus feet in length. The pipe itself is usually a strength member and must be structurally sound. Most severe erosion usually occurs in the bottom and top 50 ft of its length. Pipe sections are usually slightly tapered to step down at joints in the direction of flow. This avoids exposing a shoulder to the impingement of the upward moving catalyst.

Distribution piping is smaller, usually in the area around 10 inches. It normally operates full of catalyst.

Distribution cones, separation boxes, wear plates and lift bells are other applications in this type of unit (see Fig. 4). These take a variety of shapes and forms and are large in area requiring protection.

Automatic Hard-surfacing Processes

Many of the best hard surfacings in their weldable form exist as hard, more or less brittle materials which cannot be softened by heat treatment or bent from their as-cast shape. In this form, they cannot be drawn into wire or formed into coiled rod.

Automatic welding required feeding coiled rod through a welding machine. In automatic hard surfacing this requirement is met by placing the alloy elements in powder form in a tube and "postponing" the formation of the alloy desired until the tube rod passes through the welding arc.

Two general types of automatic welding have been used for applying automatic type hard surfacings.

The first of these is the familiar submerged arc process. The other is an open arc process in which small diameter tube rod is employed. This latter process is relatively newer.

The submerged-arc process consists of the elements of coiled rod fed through power driven rolls to a welding zone in which a flux or melt composition covers and protects the molten weld material from the atmosphere as in the usual automatic. Continuation of the welding action is made possible by regulatory devices or equipment which gear the rate of rod feed to the rate of burnoff in the welding zone.

The action of the melt in confining the metal under a viscous molten bath causes the familiar smooth top and the absence of spatter. Besides chemically protecting the weld zone from atmospheric oxidation, the melt may add some elements to the weld and remove others.

The property of adding elements to the weld from the melt is made use of in a variation of the submerged-arc process in which rod and melt combinations are used to produce hard surfacings of a desired coating analysis.

The open-arc process has other properties; and data

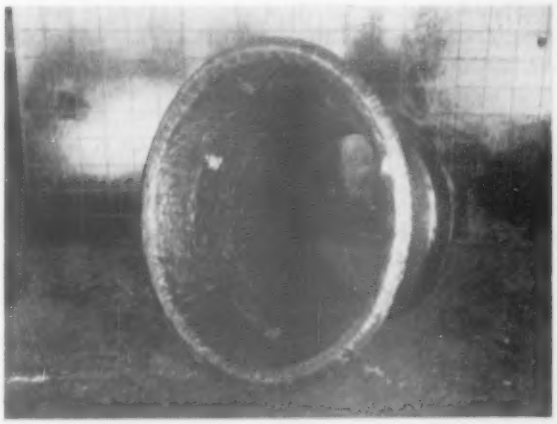


Fig. 4 Hard-surfaced lift bell inlet casting

Fig. 5 Boom arrangement for coating larger diameter pipe

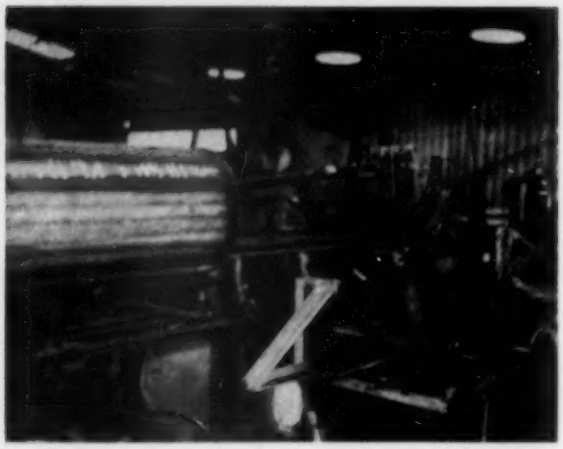


Fig. 6 Extended nozzle setup for coating small-diameter pipe

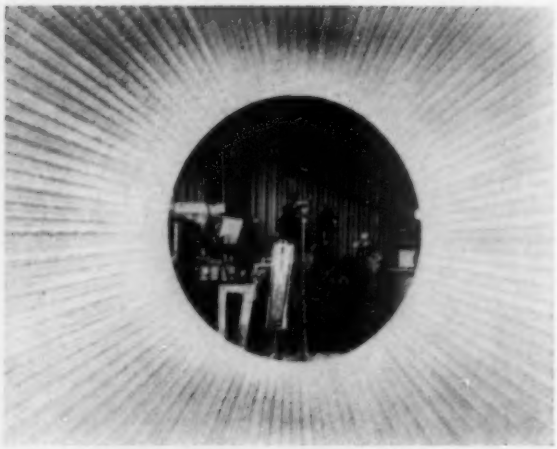


Fig. 7 Internal view of large-diameter coated pipe shows that roundness is maintained

given on its performance indicate some very desirable features for catalyst protection coating.

Welding is performed using the usual automatic equipment and small diameter tube coiled rod in open arc operation. Because of the flexibility of the small wire the process may also be used with "flexible hose" semiautomatic equipment. Surfaces of unusual flatness are produced without ripples. Smoothness is good though the surface is not the glazed type often produced with the submerged-arc process.

This process gives deposition rates that are faster per ampere of current. Dilution is thus less because of the lower current densities, a greater amount of current being applied to melting of rod than to the melting of base metal than with submerged arc. Since no melt is used, the cost of melt and cost of flux removal are eliminated. The deposited analysis is claimed to be more nearly that of the rod first because of less dilution and second because of the absence of melt absorption of chromium.

Mechanical Setups

To perform automatic hard surfacing, three general types of mechanical setups are usually used. These are:

1. A stationary or track mounted head for flat or external cylindrical surfaces.
2. A boom setup for larger internal diameters wherein the welding head and the rod coil are mounted on a boom which will carry the welding equipment through the bore (see Fig. 5).
3. An extended nozzle setup for small internal diameters wherein the welding head remains outside the pipe and a nozzle extends in to transmit the rod to the welding zone. Length of work done by this method is limited to the length of rod which may be pushed through the nozzle tube by a given head using a given type of tube rod (see Fig. 6).

A choice of a mechanical arrangement may depend upon the range of work anticipated for one setup. The boom and extended-nozzle type setups will do flat work if needed. The extended nozzle will handle much larger bore work. For most applications movement of the weld head by track mounted or straight-line traveling equipment over stationary work is usual. Manual indexing usually of the work is employed to give proper bead spacing. The exception to this is the case where it is desirable to coat an external cylindrical surface circumferentially. In this case, variable drive trunion rolls or a welding positioner is used to rotate the work under a head which is stationary mounted, or which moves longitudinally to the cylinder being coated.

Welding Procedures

The welding procedure must be directed at a number of objectives. These are:

1. Uniform thickness.
2. High analysis of essential alloys in deposit.
3. Good surface smoothness.
4. Minimized distortion.

A combination of welding conditions and bead spacings are selected which give the best balance of these requirements. Often emphasis is placed on one or more requirements to meet the individual needs of a particular component. For instance, multilayer coats will raise deposit analysis and might improve the surface. Single layer deposits will minimize distortion. Further adjustment of welding conditions and bead spacings will further reduce distortion. Figure 7 is an example of this. Distortion after automatic welding showed almost no shrinkage in diameter, about $^1/_4$-in. out of roundness and no measurable variation from straight on a 38 in. diameter and 8 ft lengths.

Direction of beads is arranged wherever possible to be in the direction of catalyst flow to minimize cross bead roughness.

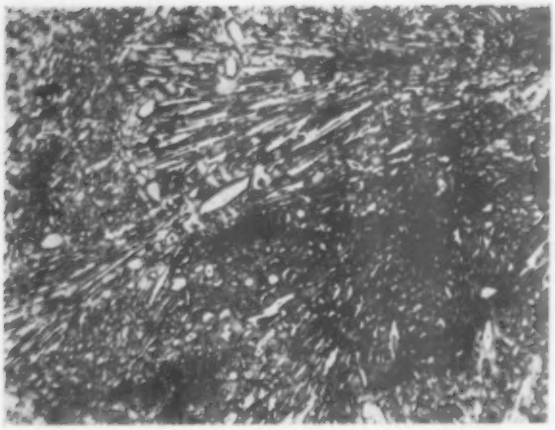


Fig. 8 Photomicrograph of submerged-arc deposit containing 13.23 chrome – 2.48 carbon

Once the spacing is determined, accuracy in maintaining spacing is very helpful. One device for this purpose is a ring with holes drilled around the periphery at the desired spacing distances. A pin through the hole in the ring and a stationary piece makes and maintains alignment.

Dilution of the weld deposit is of great importance. Selection of speeds and welding currents must be such that base metal melting is minimized. Higher voltages will normally produce a flatter topped weld and allow better blending. One set of conditions used with submerged arc is shown in Table 1.

Using submerged-arc process with a rod flux combination designed to produce a high chromium carbide containing deposit, an alloy rod type L-60 is used with an alloy containing flux H-560.

Using the open-arc automatic with small diameter tube rod some recommended conditions are as shown in Table 2.

Choice of Materials

The problem of catalyst erosion has been with us for some time. In combating it, a number of surfacing materials have been found which give successful results. During 1948 a series of tests were run in a fluid type cracking unit wherein some 54 alloys were tested competitively. The results were perhaps surprising to some in that most of the high-cost high-surface quality alloys, such as the cobalt-chromium-tungsten alloys, were found to be little better than carbon steel and that certain types of mill scale were very resistant.

The best alloys found in those tests were of the chromium carbide containing type. Most recent attention and usage has been of the high-chromium high-carbon type with or without other carbide formers present. One present specification calls for a minimum 21% chromium in the deposit with 3.5% minimum carbon or 18% chromium with other carbide formers sufficient to give 21% total.

Alloys in this area of chromium and carbon show high resistance to drawing at service temperatures of 1000 to 1100° F and are relatively independent of cooling rate during application. High-chrome alloys used earlier with less carbon showed a tendency to lose hardness and abrasion resistance after prolonged time at service temperature.

Table 3 and Figs. 8 through 11 show as-deposited analyses and micrographs of some of the available automatic materials of the high-chromium iron type.

Hardness traverses made in the submerged-arc and the small wire open-arc deposits indicate the character of the coating from surface to base metal. It is noted that the submerged-arc deposit fuses somewhat more base material (see Figs. 12 and 13).

Close inspection shows that several check cracks are visible in the coating. While they are of considerable size for checks, they do not extend below the depth of the coating. During the past 2 years, we have investigated cracking characteristics for the purpose of producing greatest structural soundness and lowest distortion.

Economy

In comparison with familiar hard-surfacing costs, the

Table 1—One Set of Welding Conditions for Automatic Coating by Submerged-Arc Method Using Tube Rod Material

Tube rod	Type No. 90 alloy—$^{3}/_{16}$ in. diam
Melt or flux	No. 80
Preheat	600° F maintained
Current	350 amp
Voltage	34
Speed	11 ipm

Table 2—Welding Conditions for Automatic Coating Using Open Arc with Tube Rod Material

Tube rod	Type No. 100 SP alloy $^{7}/_{64}$ diam
Current	275 amp
Volts	32
Speed	To suit depth
Oscillation of nozzle	To produce $1^{1}/_{4}$-wide bead

Table 3—As-Deposited Analyses Using Tube Rod Submerged-Arc and Open-Arc Methods

Rod	*C*	*Mn*	*Cr*	*Mo*	*Hardness*	*Micrograph*
$^{3}/_{16}$-in. No. 90 Submerged Arc	2.75	0.65	27.5	...	Rod analysis	...
As-deposited						
1st Pass	1.70	1.72	18.34	...	43.45	...
2nd Pass	1.86	1.84	20.51 Zr	...	45.50	...
$^{3}/_{16}$-in. No. 103 Submerged Arc						
As-deposited	4.6	3.76	32.0	0.73	Rod analysis	...
1st Pass	2.48	3.42	13.23	...	48.51	Fig. 8
2nd Pass	3.82	2.31	23.65	...	53.54	Fig. 9
$^{7}/_{64}$ No. 100 SP	4.90	1.40	26.00	1.15	Rod analysis	...
As-deposited						
$^{1}/_{8}$-in. Pass	2.84	...	14.53	0.70	...	Fig. 9
$^{1}/_{4}$-in. Pass	4.29	...	19.40	0.94	...	Fig. 10

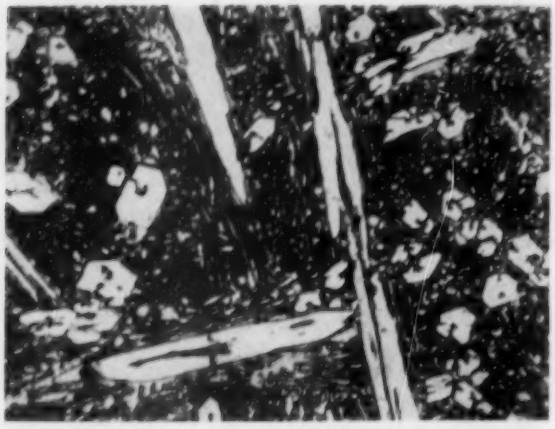


Fig. 9 Photomicrograph of submerged-arc deposit containing 23.65 chrome – 3.82 carbon

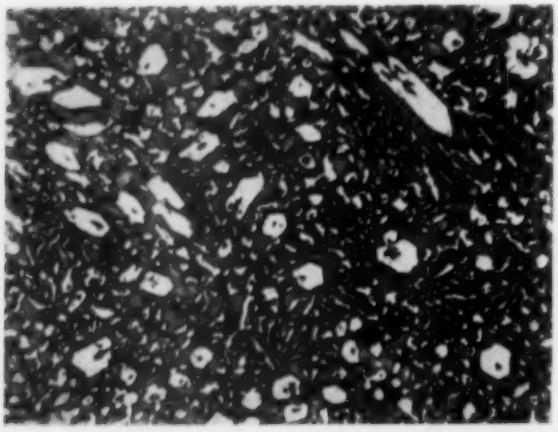


Fig. 10 Photomicrograph of open-arc deposit containing 14.53 chrome – 2.84 carbon

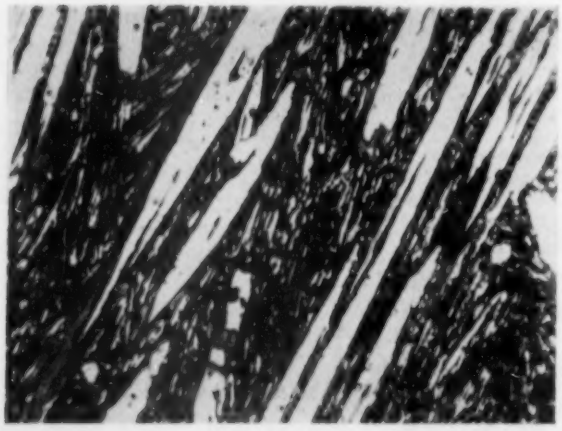


Fig. 11 Photomicrograph of open-arc deposit containing 19.40 chrome – 4.29 carbon

economy of automatic surfacing with the materials just discussed is quite outstanding.

The tabulation shown gives labor and materials costs for several types of surfacing and illustrates the considerable differences that exist between different types of surfacings applied by different means (Table 4).

Manual Applications in Catalyst Service

It has been mentioned that manual hard surfacing for catalyst abrasion has been done for some time on various components of refining units. Service life extensions of a variety of these items of up to five times "normal" presuppose outstanding service for the automatic types.

One of the outstanding manual catalyst applications from the standpoint of service has been the slide valve as used in the fluid type cracking unit (see Figs. 2, 14 and 15). Work with various manual applied coatings began in 1947 and included tests of many different materials. Besides resistance to abrasion, a requirement in this work is to maintain flatness so as to leave a full depth of coating at all points. It is interesting to note that

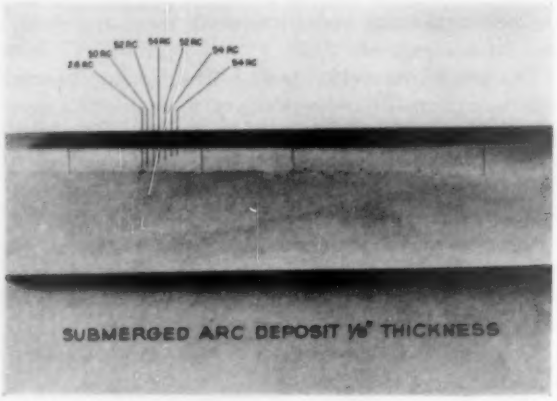


Fig. 12 Hardness traverse submerged-arc coating high chromium – high carbon material

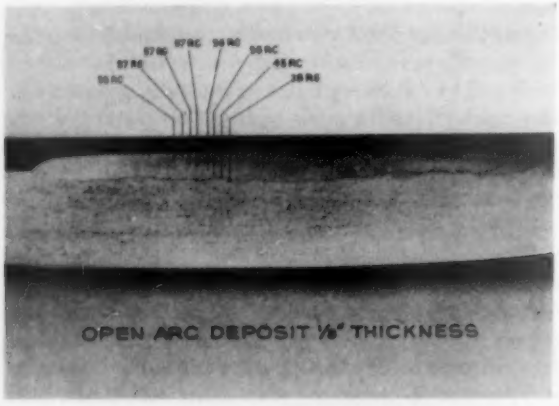


Fig. 13 Hardness traverse open-arc coating high chromium – high carbon material

Table 4—Welding Labor and Material Comparison Various Hard-Surfacing Materials and Methods

$^1/_8$-in. Surfacings

Type	*Rod cost/lb*	*Typical direct labor and materials costs*
Class 1, surfacing acetylene	4.50	0.35/sq in.
Class 1, surfacing manual arc	4.50	0.27/sq in.
Class 2, surfacing manual arc	2.50	0.22/sq in.
Class 3, surfacing manual arc	1.25	0.14/sq in.
Class 3, surfacing automatic submerged arc	1.25 (Including helper)	0.08/sq in.
Class 3, surfacing automatic open arc	1.25 (Including helper)	0.06/sq in.

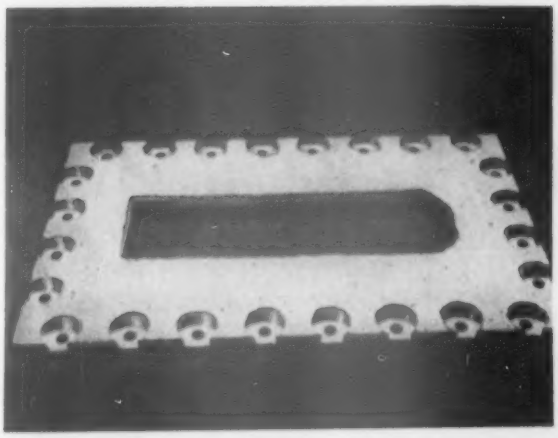
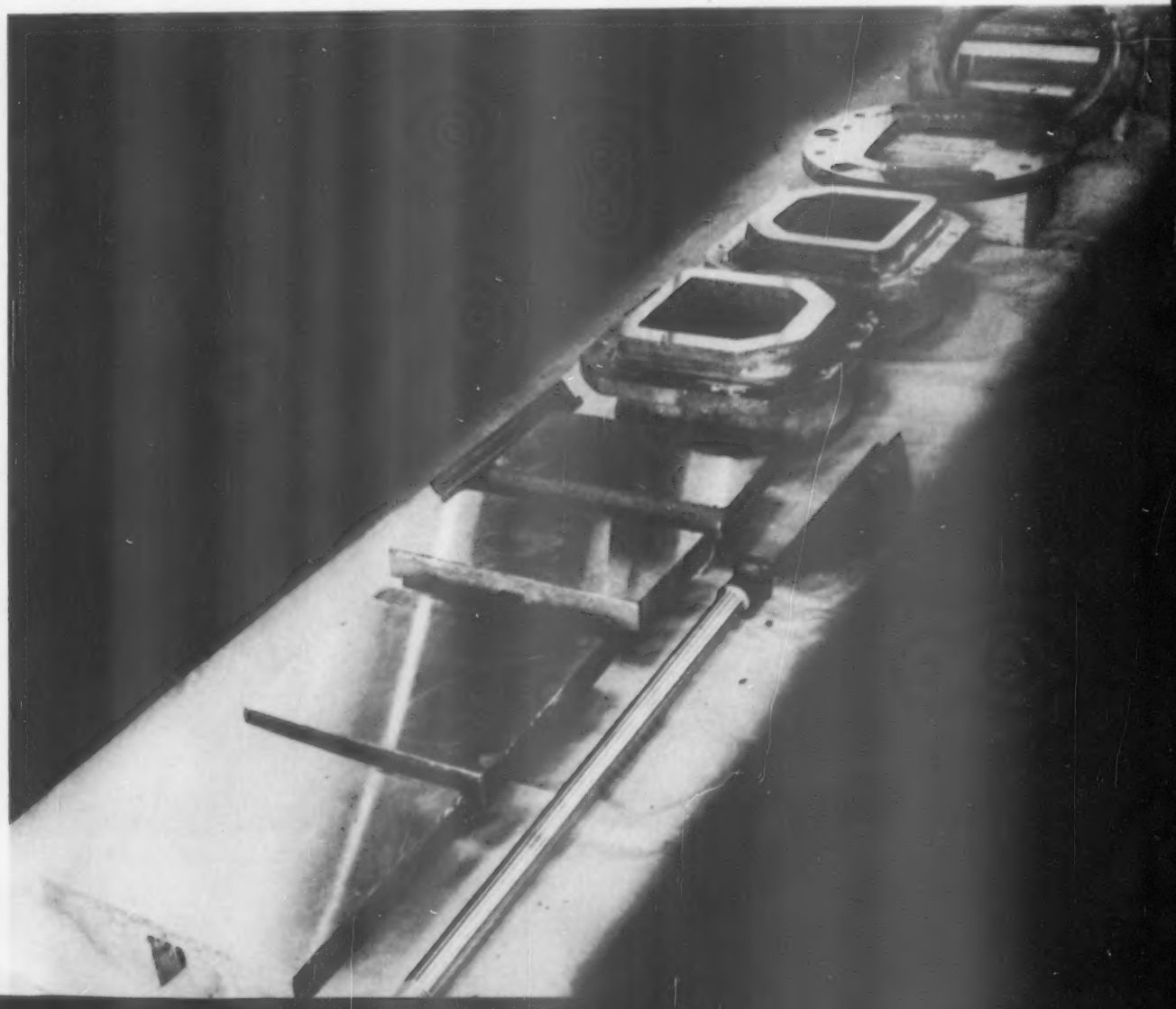


Fig. 14 Fluid-cracking unit slide valve insert hard surfaced and ground

the material now used contains only about $^1/_2$ as much chromium as the materials employed in the automatic work just discussed, though it also contained boron. Service lives of 3 to 5 times the uncoated slide valve are common with this coating. Work is presently being done aimed at comparative evaluation of this coating

Fig. 15 Fluid-cracking unit slide valve parts hard surfaced and ground



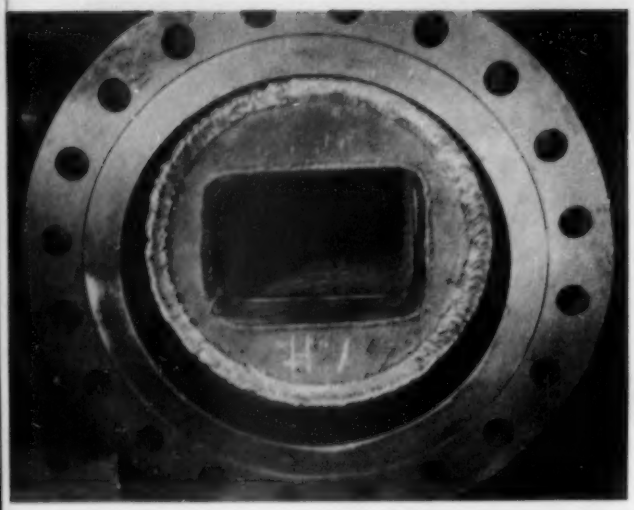


Fig. 16 Moving-bead unit plug valve hard surfaced in plug and gate areas

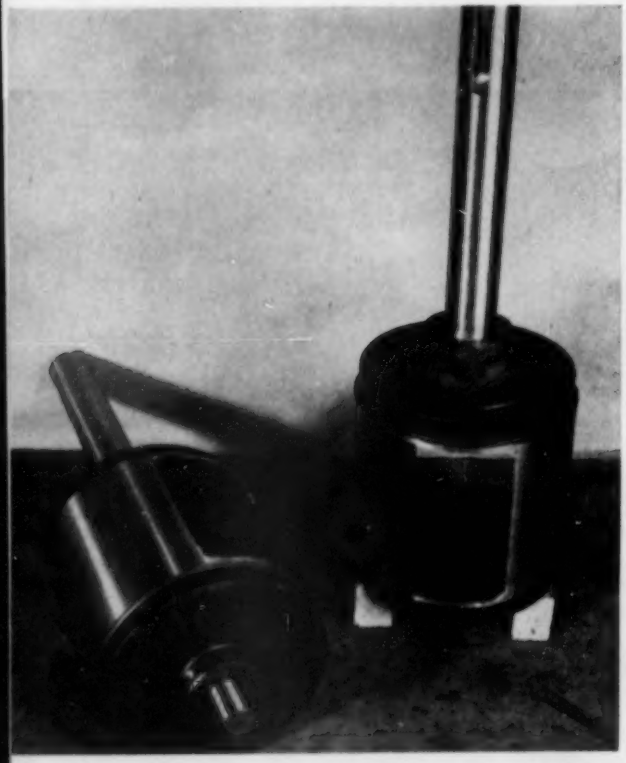


Fig. 17 Moving-bead unit valve plugs internally faced

with respect to the higher chrome types.

Another manual application of interest in the catalyst unit is that of the port openings and plugs of 14- and 24-in. plug valves which handle catalyst in the moving bead cracking unit (see Figs. 16 and 17). These valves operate with a running clearance which must be closely held; hence low distortion on the plug and seat are very desirable.

Unfaced and as removed from service, some of these valves had to have a few hundred pounds of lost metal replaced before surfacing could begin; so severe was the erosion. Different sets of these valves have been processed with both the high-chrome iron and with the medium-chrome carbon boron type.

The lift bell has been done manually but is a good automatic application, using the same surfacings discussed earlier.

Heavy cast elbows for moving bead reforming service are a'so done manually and are usually magnafluxed or otherwise crack inspected for base metal damage.

The lift screen of the moving bead cracker employs an exception to the usual surfacing (see Fig. 18). Because of the multiplicity of holes and the narrow areas between, surfacing is done with a nickel-chrome-boron alloy sprayed and torch fused.

Conclusion

In passing, a point should perhaps be made here which is often forgotten. Any arc-applied hard surfacing is necessarily a mixture of the surfacing material and the base metal. The extent of this mixing depends on the procedure used and the skill of the fabricator. Hence to refer to an arc-applied coating by the name of the surfacing material only is to say little about its probable quality.

The considerable recent progress in materials and techniques of application might be expected to continue. Chromium and carbon contents for this work are still rising. Certain new metal complexes which show extraordinary surface hardness are other possibilities. Work is presently going on aimed at improvement of the means of application. In the meantime, the present materials and methods are an important tool for the oil refiner in his battle against depreciation.

Acknowledgments

The author is indebted to the Stoody Co., Haynes Stellite Co., the Lincoln Electric Co. and Coast Metals, Inc.; Henry Warren and A. T. Cape for items of data herein presented.

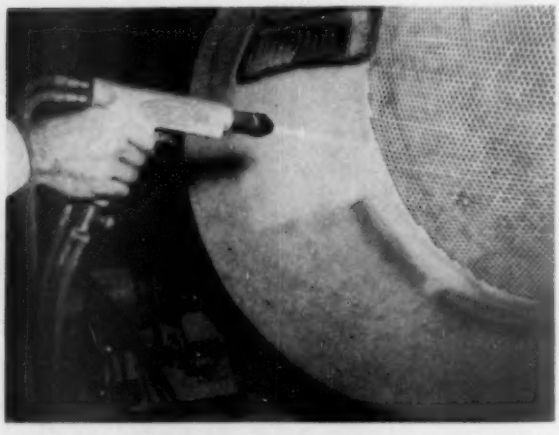
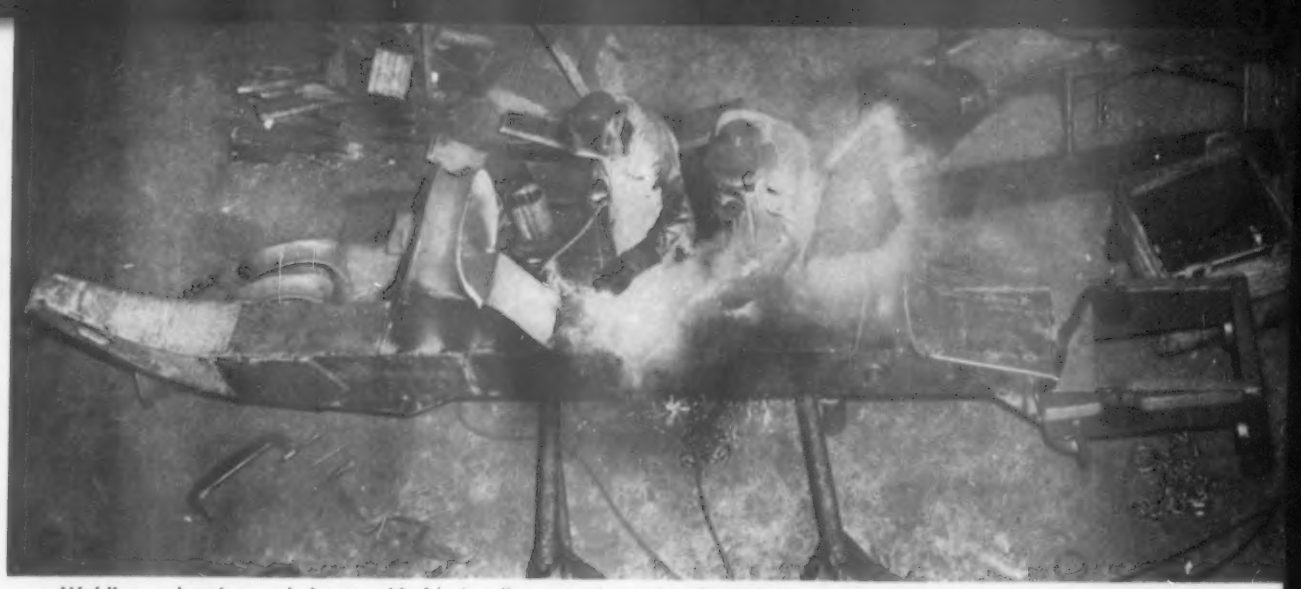


Fig. 18 Moving-bead unit lift screen hard surfaced by the spraying and torch-fusing method



Welding a logging arch boom with $^{3}/_{16}$-in. diam metal-powder electrodes

METAL-POWDER ELECTRODES AND THEIR APPLICATIONS

The relative operating qualities of iron-powder electrodes and conventional electrodes are outlined and discussed

BY E. DI LIBERTI

Introduction

The introduction of iron-powder coated electrodes to American industry was one of the most noteworthy contributions to the arc-welding industry since the development of low-hydrogen electrodes. Much of the controversy and confusion associated with the initial use of the radically different iron-powder electrodes is gradually disappearing as the result of the publication of AWS Specification A5.1–55T. The value of this specification cannot be overemphasized because it provides both the electrode manufacturer and the user with mutually acceptable technical standards which form the foundation upon which future advancements and improvements of iron-powder electrodes can be built.

Although it is generally conceded that the addition of iron powder greatly influences electrode performance, there are still some misconceptions as to the precise part that iron-powder additions play, causing certain misunderstandings in the use and application of iron powder electrodes. When powdered iron is added to an electrode coating, there is sufficient "excess heat" in the arc to melt the fine particles of iron. This melted iron is recovered in the puddle and becomes part of the weld metal. One must realize that the electrode designer can use amounts of iron powder ranging from 0 to approximately 60% of the coating weight. With this wide range it is evident that any single percentage of iron powder selected will be a compromise. With small additions of iron powder, high deposition rates cannot be achieved. Excessive iron powder will produce a high deposition rate but the electrode will be so "cold" that it would not be commercially usable. The optimum amount of iron powder added to an electrode coating is the greatest quantity that can be used without impairing the arc action and handling qualities.

Electrodes containing large amounts of iron powder in the coatings will have large "weld puddles" because of their high deposition rate and are usable only in the downhand position. In vertical and overhead welding a large weld puddle cannot be controlled. Therefore, in designing an electrode for use in these positions, only small amounts of iron powder can be used, resulting in an electrode that will show little significant economic advantage over standard types which contain no iron powder. Because iron-powder electrodes have operating qualities that are different from the conventional

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types a review of these differences will be made.

Slag

In general it will be found that iron-powder electrodes produce slightly more slag than conventional electrodes of the same wire diameter. In spite of this, the iron-powder electrodes have no more slag entrapment in the weld deposits than do the conventional types. This is because the slag is maintained as stiff as possible without impairing the other operating qualities of the electrode. As evidence, X-ray results show that excessive slag does not get trapped in the weld metal.

Arc Action and Arc Spread

Generally speaking, iron-powder electrodes are of the a-c, d-c type and seem to have a "softer" arc than the conventional type electrodes. This is because the heavy iron-filled coating on the electrode forms a deep crucible that effectively protects the arc and reduces the exposure of the operator to much of the arc stream. This, of course, is an advantage because higher current can be used without discomfort to the welder. Welders not familiar with iron-powder electrodes usually employ a dragging technique, i.e., holding the electrode in light contact with the plate. However, after acquiring some experience with iron-powder electrodes most operators prefer to maintain a short "free arc." With this technique they avoid any discomfort that might come from the coating crumbling when maintained in contact with the plate. This "free arc" technique also gives better control of the arc and weld deposit.

The arc spread for iron-powder electrodes is considerably wider than that for the conventional types. This has advantages in some applications, such as making butt welds on thin materials.

Arc Intensity

Because of the deep crucible that is characteristic of iron-powder electrodes, they normally operate at higher arc voltages than their conventional counterparts. For example, it is not uncommon for iron-powder electrodes to operate at 38 to 40 volts whereas conventional electrodes of the same diameters and operating under similar conditions have arc voltages of only 24 to 26. As a result of this higher arc voltage, together with the higher currents needed for iron-powder electrodes, the total power required is greater than that needed for conventional electrodes of the same diameter. It is therefore essential that the welding machines used with iron-powder electrodes be large enough to furnish the greater amount of power needed.

Restriking Qualities

One of the original claims made for iron-powder electrodes was the fact that they have such outstanding starting and restriking qualities. It was demonstrated that the welder had only to touch the electrode to the plate and welding would commence immediately without any other motion of the part of the welder. This quick starting characteristic has had to be modified for safety reasons. If a coating is so conductive that it will start immediately on contact with the workpiece, the operator is, in effect, working with an uninsulated electrode; one which will arc through the sides of the coating if accidentally placed in contact with the work. This is hazardous, especially when operating in confined quarters where it is difficult to avoid bumping the side of the electrode against the workpiece. Electrode designers have therefore compromised between the so-called touch starting characteristics of a very highly conductive coating and one that is insulated through the sides. This has resulted in an electrode that is insulated but still has extremely fast starting qualities. After the arc is broken and even if the electrode is allowed to get cold, the fused portion of the slag will be sufficiently conductive to provide immediate restriking.

Cleaning

There is no doubt that certain economies can be realized because of the exceptionally easy slag removing qualities of iron-powder electrodes. In many cases slag will actually curl up off the weld as the workpiece cools down. In instances where the structure is subject to severe heat during the welding operation, the slag requires only a light tap in order to be removed from the surface. This simplifies the cleaning problem because power equipment is not needed.

Handling Qualities

Iron-powder coated electrodes are extremely easy to use. The only instructions that need be given to an experienced welder is to tell him that he should drag the electrode along the joint and hold a long lead angle about 15 deg in the direction of welding. These are the major differences between using the E6024 type of electrode and the conventional E6012. With a little experience in using iron-powder electrodes, welders find that they can use a short "free arc" and adjust the forward motion to produce excellent welds at fast welding speeds.

Craters

An experienced welder will quickly discover that it is difficult to fill in craters when skip welding with iron-powder electrodes. When the arc is broken the crater will be hollowed out and the customary technique of stepping back slightly and pausing for a short instant before breaking the arc is not completely adequate. Some welders overcome the skip-welding crater problem by almost completing the fillet for its total length; then carrying a long arc to a point beyond, and working back toward the crater with a full bead. With practice, this technique is quite simple and the bead has neat ends with no visible craters showing where the arc was broken.

Turning Corners

With conventional electrodes, the operator finds that he is not restricted to a narrow angular position of

electrode while welding. Therefore, when it becomes necessary to turn a corner he simply steers the electrode around the corner and proceeds in the new direction. With iron-powder electrodes the slag may cause some difficulty. To avoid slag interference the welder must be certain, when turning a corner, that the lead angle is properly adjusted. In some cases it is best to end both beads in the corner rather than try to make the turn.

Speed

Although speed is one of the outstanding advantages that can be achieved from iron-powder electrodes, it is probably the feature that has caused the most difficulty from the standpoint of users. The complexities of burn-off rates, deposition rates and travel speeds cannot readily be translated into an accurate comparison with costs obtained with conventional electrodes unless the job involved is studied very carefully. Therefore if the user does not thoroughly analyze the results of the iron-powder operation, its speed advantage may not be readily apparent. In some instances the particular applications cannot effectively utilize the speed of iron-powder electrodes, and any economic savings are nullified.

The accompanying drawings graphically illustrate the economic advantage of iron-powder electrodes. For comparison purposes, popular diameters of conventional E6012 and the E6024 iron-powder electrodes have been selected (Fig. 1). If the contents of each 50-lb box were melted on a slab of steel (Fig. 2), it would be found that, within certain periods of time, roughly the same weight of deposit metal from each box would be recovered. If, instead, these deposits had been made into $^1/_4$-in. fillets, the total footage per box (Fig. 3) would also be nearly the same. However, a study of the time required to melt these various electrodes (Fig. 4) reveals an amazing difference. The iron-powder electrodes permit welding speeds of about twice those of the conventional types. On many applications this can reduce the total welding cost as much as 50%.

In the past, situations frequently arose where it was not practicable to use as large a diameter iron-powder electrode as the conventional electrode that was used

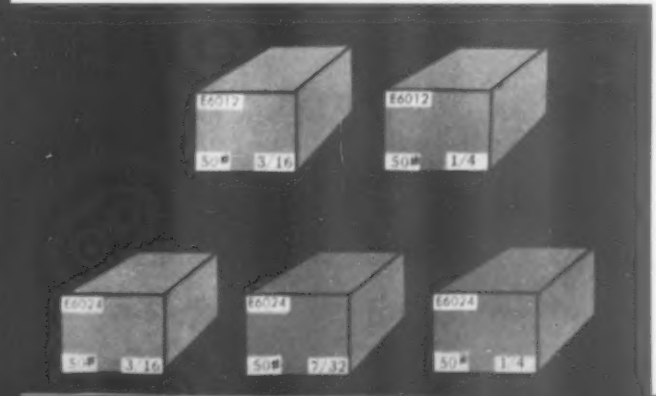

Fig. 1 Conventional E6012 electrodes and metal-powder electrodes selected for study

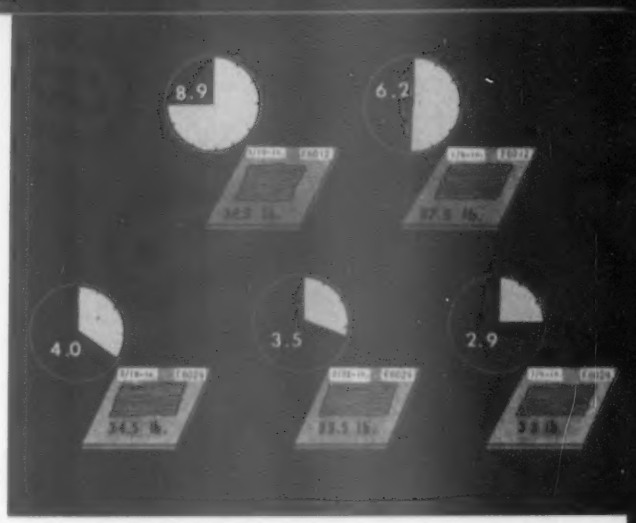

Fig. 2 Amount of weld metal secured from each standard carton, together with the deposition time

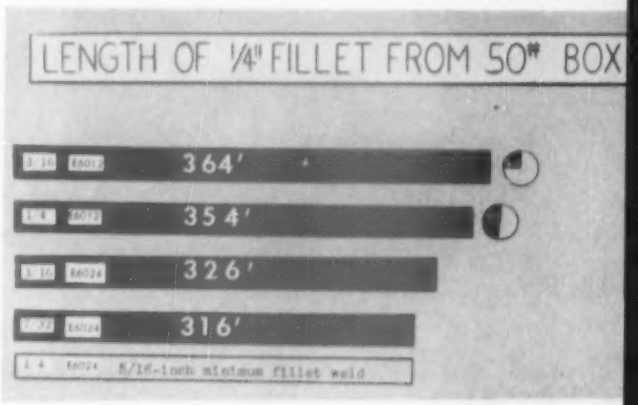

Fig. 3 Volume of weld metal shown in Fig. 2 is expressed here in terms of $^1/_4$-in. fillet welds

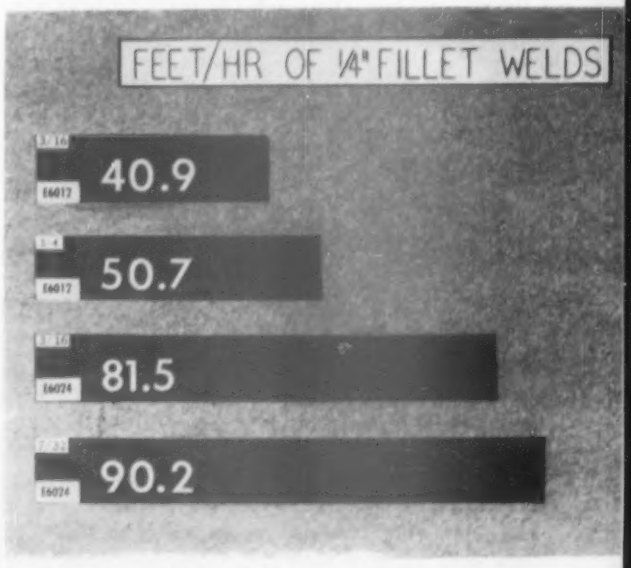

Fig. 4 Bar graph illustrating the speed advantage of metal-powder electrodes over the conventional E6012 type

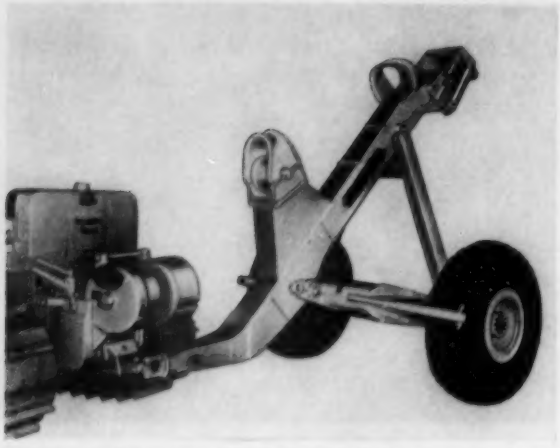

Fig. 5 Completed arch boom assembly after welding with 1/4-in. diam metal-powder electrodes

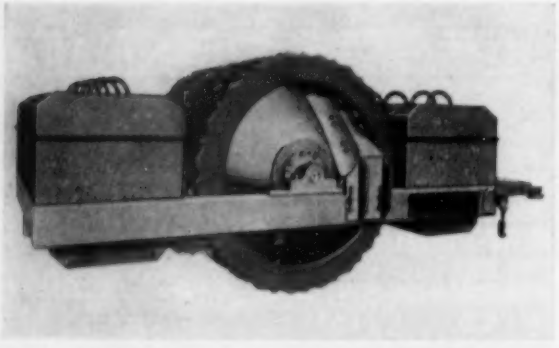

Fig. 6 Grid roller, completely fabricated and ready for the grueling tasks of road construction

to produce a certain size fillet. Normally the arc spread of the iron-powder electrode is wider than that of the conventional type, and the resulting fillet also has a larger dimension. With recent improvements in iron-powder electrodes, this situation has been eliminated to the point where experienced welders are now able to produce a "compromise" fillet with iron-powder electrodes that have essentially the same leg size as those produced with conventional types of the same diameter. This has been noted especially where the welders are on a wage-incentive system and when this is accomplished, the maximum savings from iron-powder electrodes are achieved.

The first iron-powder electrodes manufactured in this country were made with rutile coatings, common to types E6012 and E6013, to which a high percentage of iron powder was added. These have now been classified in the AWS Specification as E6024. As they are primarily variations of E6012 and E6013 coatings, it follows that the addition of iron powder will not significantly change the quality of the weld metal.

Even though the ductility required of iron-powder E6024 weld metal is only 17%, these electrodes give both high yield and high tensile strength, together with fine X-ray properties and good impact strength. Very satisfactory results are achieved when these electrodes are used on weldments subjected to severe service, as shown in the lead photograph which depicts the fabrication of a large boom used in the lumber industry to handle logs. The completed machine is illustrated in Fig. 5. Another piece of heavy-duty equipment which utilizes the fine mechanical properties of metal-powder electrodes is the grid roller (Fig. 6) used in road construction to pack down loose rock, earth and gravel fill. Fabrication of the grid for this machine is shown in Fig. 7. Because, the selection of an electrode is dictated by numerous requirements ranging from design, operating conditions, service requirements of the structure, etc., iron-powder electrodes of the E6024 type should not be used on applications where another type of electrode is better suited. The misapplication of any type of electrode can be a disservice not only to the initial user but also to the user of the end product which is produced from that electrode.

Other types of coatings containing iron powder are gradually being developed, and will combine the particular qualities of a conventional coating with the speed that results from adding iron powder.

While iron powder can be added to any of the conventional electrode coatings, it does not follow that its addition will automatically give advantages over the conventional counterpart. This was forcefully illustrated with the development of the Type E6027 iron-powder electrode which is basically an E6020 coating to which iron powder is added. The E6020 electrode is a highly developed product which operates at high welding currents to give fast deposition rates and excellent X-ray quality weld metal. To these features are added good handling qualities and superior fillet welding properties. In general, the addition of iron powder to the E6020 coating disrupts its balance to such an extent that no advantage is gained. The insignificant speed advantage that may be realized by adding iron powder to the E6027 electrode is offset by the higher price of the product and the poorer handling qualities it produces. The iron powder types, for example, are not usually as satisfactory for horizontal fillet welding as the conventional and highly developed E6020.

Table 1—Relative Physical Properties of Low-Hydrogen Iron-Powder Electrodes

	E6024	*E7016*
Tensile strength, psi	85,000	89,500
Yield strength, psi	74,750	73,250
Elongation in 2 in., %	17	30
Reduction in area, %	27.5	67.1
Charpy V-notch		
Room temperature	57	95
0° F	18	50
−40° F	7	12

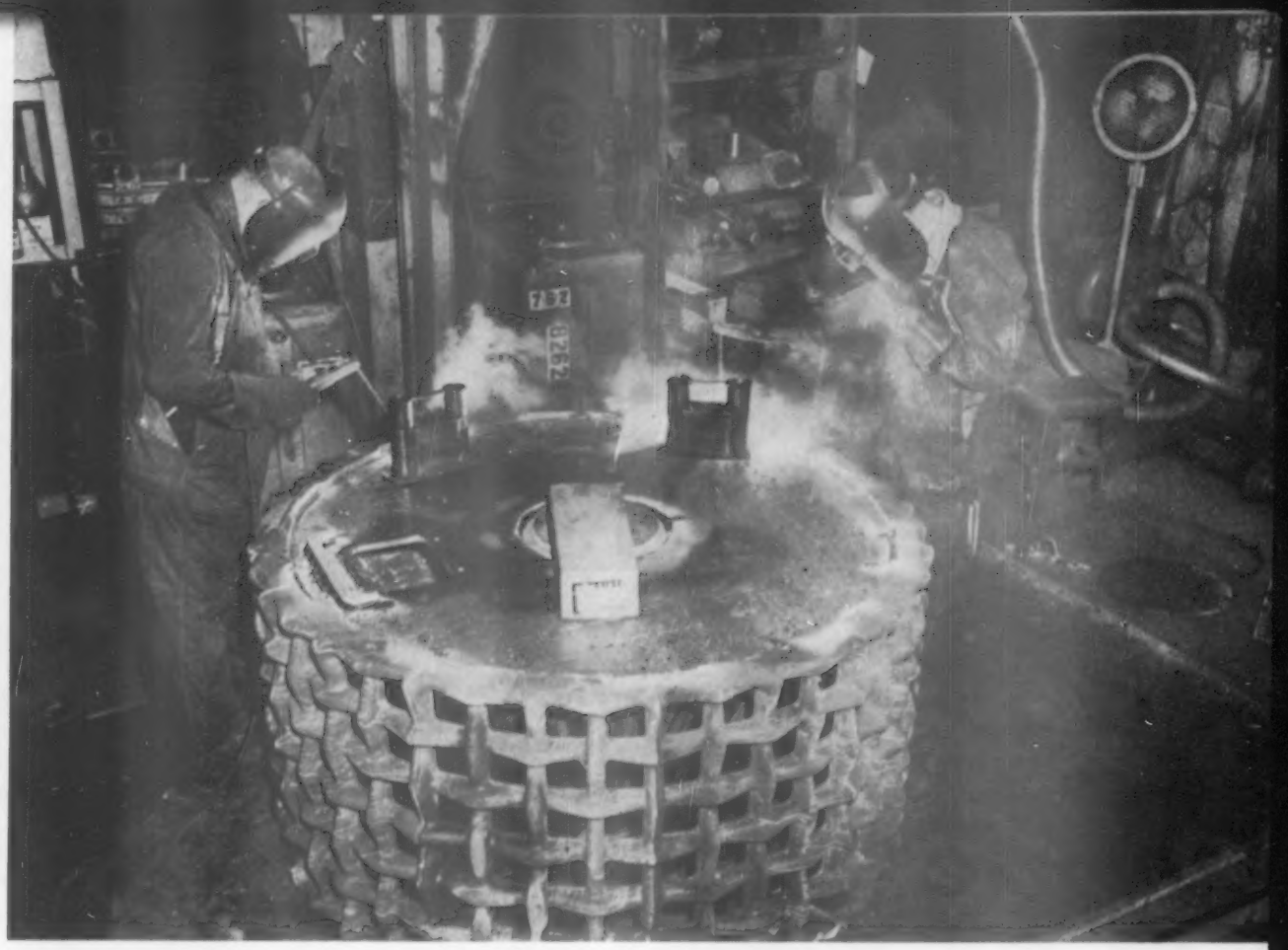

Fig. 7 The rugged roller of the machine shown in Fig. 6, being fabricated with metal-powdered electrodes

One of the most recently developed iron-powder electrodes is the low-hydrogen type. This, of course, is essentially a low-hydrogen style of coating to which large amounts of iron powder are added. While it is generally recognized by the welding industry that low hydrogen electrodes produce weld metal of extremely high quality, shop and production people have all too frequently been reluctant to use them because of their lower speeds and their slag problems. In other words, speed is emphasized at the expense of quality. Furthermore, it is invariably necessary to retrain welders who are required to use low-hydrogen electrodes even though they may be experienced on other styles of electrodes. The addition of iron powder to the low-hydrogen coating produces an electrode which is easier to use and also gives speeds which compare favorably with the faster electrodes of the conventional types. Therefore, welders do not hesitate to use the low-hydrogen iron-powder types, (tentatively classified as AWS E6018 for all position and E6028 for downhand type) particularly where the high quality of the low-hydrogen weld metal is demanded or is an advantage. Table 1 displays the relative physical properties of E6024 and E7016 low-hydrogen iron-powder electrodes.

The low-hydrogen iron-powder electrode is chiefly used in welding medium- and high-carbon steels and high-sulfur steels. These are typical of the hard-to-weld steels on which conventional low-hydrogen electrodes have been used.

Recently there has been considerable interest in the use of iron-powder low-hydrogen electrodes for jobs erected in the field. This type of work, however, imposes a demand that the electrodes be suitable for welding in the vertical and overhead positions. The smaller diameters, such as the $^1/_8$ in., have already been designed to weld in these positions by reducing the iron-powder content. This, of course, is a compromise which results in a reduction in welding speed. But the larger diameters cannot be modified to achieve the all-position feature without a great sacrifice in speed, which could nullify their chief advantage.

Conclusion

Metal-powder electrodes are recognized as a new and important tool in the welding industry. In common with most new tools and processes, however, it will require considerable time and study to arrive at an accurate appraisal of the maximum advantages they offer.

Radiant heat piping being laid on crushed rock for a floor panel

ECONOMICS OF WELDING SMALL, NONCRITICAL PIPE

Welding described as being the most economical and efficient pipe joining method known today

BY H. A. SOSNIN

Introduction

During the past forty years, or so, all critical pipe and most large diameter pipe has gradually been changed from mechanical methods of joining to welding. Much of this change was forced on the industry by steadily increasing pressures and temperatures.

But a great deal of this change has taken place for economic reasons too. When an installer was required, by one reason or another, to weld pipe he discovered that it was cheaper and easier to weld than to join pipe by other methods. He then continued to weld pipe.

Over the same period of time pipe welding, which started with the larger sizes, has gradually taken over successively smaller sizes. When pipe was first welded, in this country, most contractors welded 8 in. and larger pipe, but threaded anything smaller. While they were welding the larger pipe, 8 in. and up, they were telling themselves and others that they couldn't afford to weld anything smaller. They said it was lots cheaper and easier to thread the smaller sizes, 6 in. and down. During the ensuing years pipe welding has expanded to take in smaller sizes, until today nearly all steel pipe $2^1/_2$ in. and larger is welded. Now there are some contractors who are saying the same thing about welding small pipe, that it is too expensive for common practice. But today they mean smaller than two and a half inch. Some steel pipe 2 in. and smaller is welded. Welding pipe in these

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smaller sizes will become more widely practiced for several reasons. All of them are concerned with economics, to a greater or lesser degree.

Fields of Economy

The first phase is the economy due to quality. There is probably no one nowadays who does not readily agree that a butt-welded pipe installation is the best steel pipe installation in any size. A butt-welded installation has the smoothest lines on the inside and on the outside. Figure 1 is a picture of inside and outside of pipe threaded on one end and welded on the other, for comparison. Butt-welded piping offers less resistance to flow, it is easier and cheaper to insulate, and the insulation is better. Butt welded piping does not leak. It lasts longer. It even looks better. It takes up less space and can be installed with ease in locations that are difficult for threaded pipe. Figure 2 is a group of small pipe lines which are tight against a wall. Some of this pipe was made up on the floor. Welded pipe can be fabricated on the floor or in a shop, and shipped and handled a great deal easier than threaded pipe. This is a good example of pipe having a pleasant appearance, in a small space, in an area hard to get at, and it will never need maintenance.

Fig. 1 Inside and outside of pipe butt welded on one end and threaded on the other end for comparison

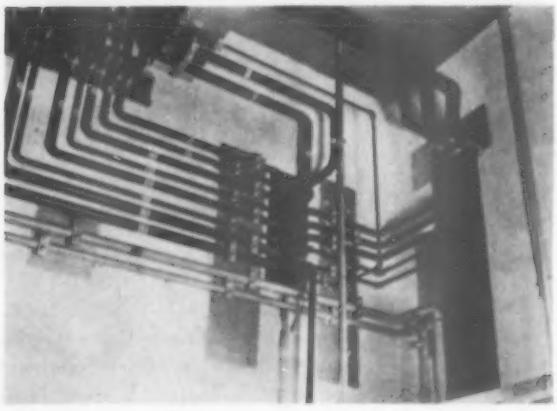


Fig. 2 Compactness and easy installation of small butt-welded pipe

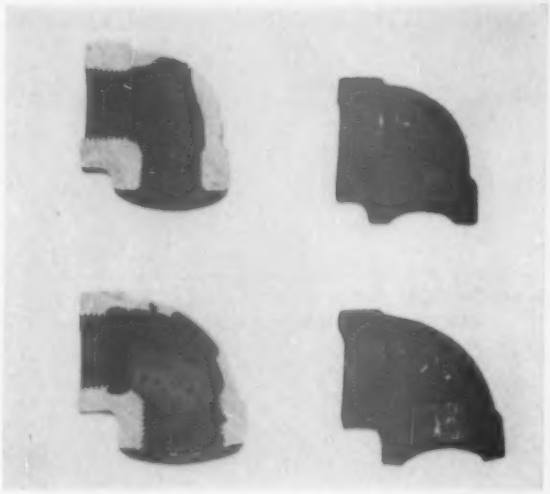


Fig. 3 Threaded pipe fittings which failed in 150 psi saturated steam service

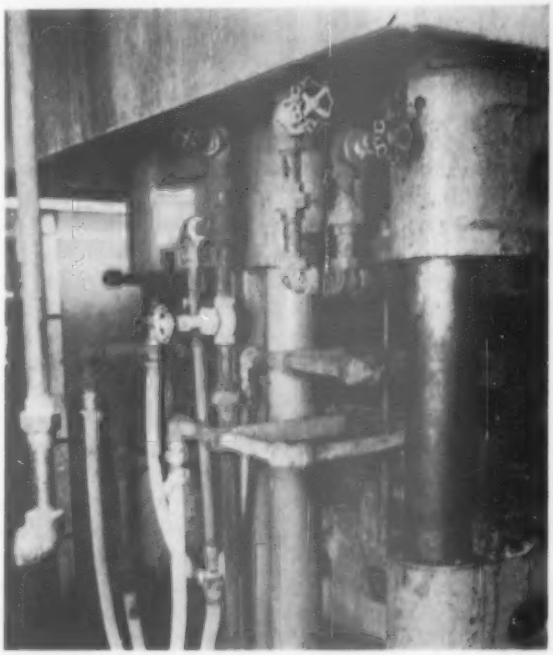


Fig. 4 Press on which the fittings shown in Fig. 3 were installed

That brings the discussion to another area of economy—an economy due to low maintenance cost. Welded piping does not work itself loose at the joints. Welded piping lasts longer, therefore does not have to be replaced as often. Figure 3 shows pipe fittings which failed in saturated steam service of 150 psi after three months of service. They were three hundred pound malleable-iron threaded fittings. In the same installation, and same service, butt weld fittings have lasted more than twice as long. Figures 4 and 5 show the press these fittings were taken from when it was piped with threaded fittings, and after it was changed over to

Table 1—Comparative Wall Thickness of Schedule 40 Pipe Before and After Threading

Nom. Size	*Sch. 40 pipe wall*	*Depth of Thread*	*Effective pipe wall*
2 1/2	0.203	0.09850	0.105
2	0.154	0.06957	0.085
1 1/2	0.145	0.06957	0.076
1 1/4	0.140	0.06957	0.071
1	0.133	0.06957	0.064
3/4	0.113	0.05714	0.056
1/2	0.109	0.05714	0.052

Table 2—Comparative Wall Thickness of Schedule 40 Pipe Butt Welded and Schedule 80 Pipe Threaded

Nom. size	*Sch. 40*	*Sch. 80*	*Sch. 80 threaded*
2 1/2	0.203	0.276	0.178
2	0.154	0.218	0.149
1 1/2	0.145	0.200	0.131
1 1/4	0.140	0.191	0.122
1	0.133	0.179	0.110
3/4	0.113	0.154	0.097
1/2	0.109	0.147	0.090

welded piping. There are innumerable examples which follow this same pattern.

Another important area of economy is tools and equipment. This applies to original cost, replacement and repair, and moving the tools and equipment. A small, relatively inexpensive, oxyacetylene welding outfit can do anything that needs to be done to any pipe from 1/8 in. through 8 in. It can cut, weld, heat to bend, solder or braze. This outfit and a pair of small cylinders can be hauled in the trunk of a small car. One man, in two trips, can carry the outfit and cylinders wherever he wants them. Cutters, dies and wrenches for pipe, from only 1/2 to 4 in., cost considerably more than the welding equipment, without any power devices. Power operation adds even more. And it takes a truck to haul the mechanical equipment around.

The largest single area of economy is in material. The commonest way of joining small pipe is by threading. Figure 6 shows a threaded joint on one end of a piece of Schedule 40, two 2-in. pipe and a welded joint at the other end. Half the pipe wall is cut away by threading. Half of all the pipe is wasted, because no amount of strength or added wall between the threads makes the piping system any stronger at the threads. Not only is the pipe wall halved at the thread, but a sharp notch is cut there. This weakens the pipe far more than is usually realized. This kind of threaded joint, with about three feet of pipe on each end, can be broken at the thread, by hand. The welded joint is as strong as the pipe.

Greater Efficiency Through Welding

Table 1 shows the extremely light pipe wall left after threading. Increasing pipe wall, going to heavier or stronger pipe, does not improve quality or increase strength as much as changing over to welded joints. Table 2, dealing with comparative wall thickness, shows that Schedule 40 pipe welded has more wall thickness than Schedule 80 pipe threaded.

The strength of the Schedule 40 pipe welded is far

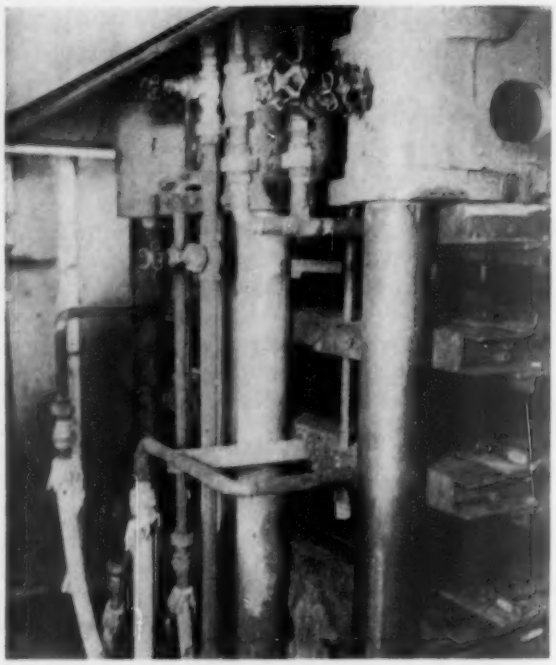


Fig. 5 Same press shown in Fig. 4 after it was repiped using butt-weld fittings

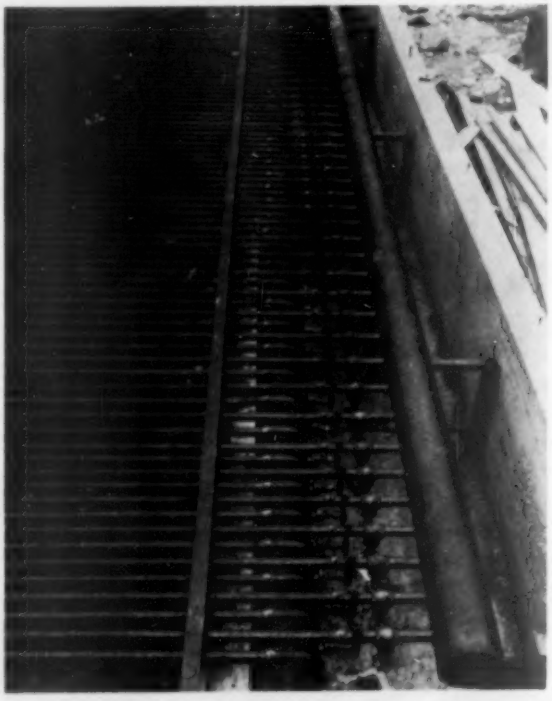


Fig. 6 This is 1 1/2-in. Schedule 40 pipe from a header below a skating rink

greater than the Schedule 80 pipe threaded, and there is more advantage to the welded pipe than the difference in effective wall thickness would indicate. A Schedule 40 welded piping installation should cost 30% less than a Schedule 80 threaded pipe installation, yet would be a

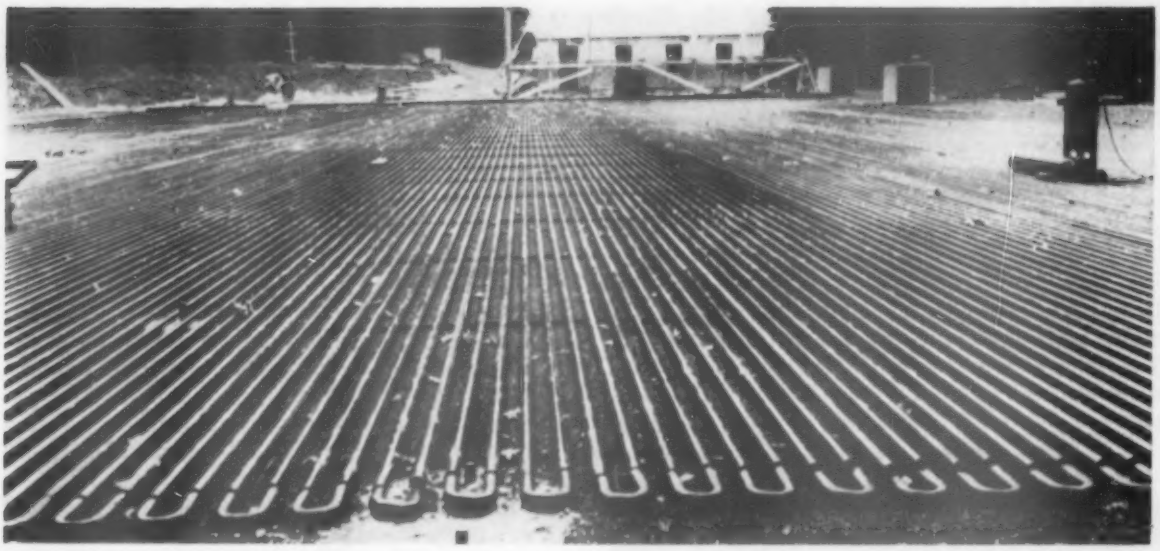


Fig. 7 This is 1 1/2-in. Schedule 40 pipe coils laid in the bed of a skating rink

great deal better because of more efficient flow, lower maintenance and greater strength. It would also be easier and cheaper to insulate and would fit in a smaller space.

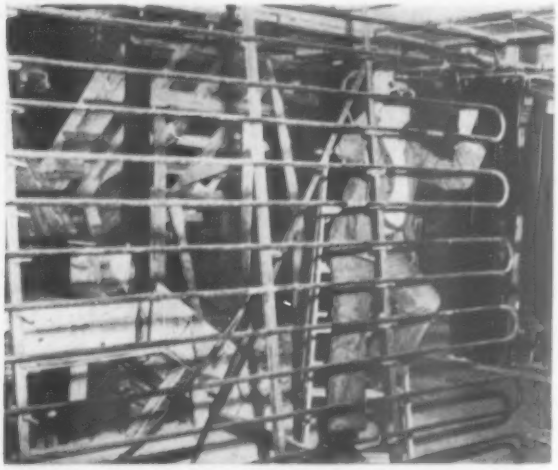


Fig. 8 Radiant heat piping being fabricated on the job-site for ceiling coils

Table 3—Comparing Welding Time with the Time Required to Cut One Thread and Tighten a Fitting

Nom. size.	*Threading and fitting, min*	*Weld, min*
2 1/2	15	10
2	10	8
1 1/2	8	7
1 1/4	6	6
1	5	5
3/4	5	5
1/2	4	4

There are many people who realize all the previous facts and conditions, agree that they are correct and say they prefer welded pipe installations, but that the welding labor costs so much they cannot afford it. The people who say that are the people who have not welded much pipe. Welding labor on larger pipe, take 8 in. as an example, is half the threading labor and the welded joint is immeasurably better. As the pipe comes down the scale in size, the labor difference disappears until small sizes, such as 1/2 in., take the same welding time as threading time. But at no size does the threading take less time than welding. Even in the smallest sizes, a threaded job, which is comparatively poor, costs the same as a butt-welded job which is extremely efficient. Many people who work with pipe think of welded piping in large sizes and threaded piping is small sizes. But let us compare welded and threaded piping in the same sizes. If it is more efficient and economical to weld 10-in. pipe than to thread 10-in. pipe, it is also more efficient and economical to weld 1-in. pipe than to thread 1-in. pipe. Table 3 is a comparison of the time it takes to cut one thread and tighten a fitting, as compared to making one weld; that is, it compares time for threaded and welded joints.

These are averages for hundreds of joints by many different mechanics in different locations. The threads were hand cut, and the welds were all in position.

Not only does the weld take less time in most cases, but much less physical effort is required. Therefore the mechanic is not as tired and his work is better.

Typical Installations

Figures 6 and 7 are pictures of piping for a skating rink. The coil piping is 1 1/2 in. An average mechanic makes an average of 55 to 60 such welds in position in an 8 hr day. He can make 70 a day if he wants to.

The lead illustration and Fig. 8 are typical radiant

heating floor coil installations. Fifty welds per day in anything 2 in. and under is considered a fair 8-hr work in this field. In a 10-hr day, men have made 100 welds each when they were on piecework. Men simply do not make that many threaded joints in a day.

Figure 9 is a picture of a bank of oil transfer pumps. This piping is 1 in. and $1^1/_4$ in. The first installation, just like this one but with threaded pipe, has leaked off and on and required a good bit of maintenance. When a second installation was required the owner said he wanted the pipe welded. He did not care about cost. He just wanted that oil pipe tight. A close check was made on the cost during the installation of this job. The piping cost was less than on the other set of pumps which had been threaded. The pumps shown in Fig. 9 took two men one day. They were set in position and completed in 2 hr of the second day. There was not one little sweat leak. The original installation of threaded pipe took two men a day and a half, and they spent another day and a half trying to tighten up and stop leaks.

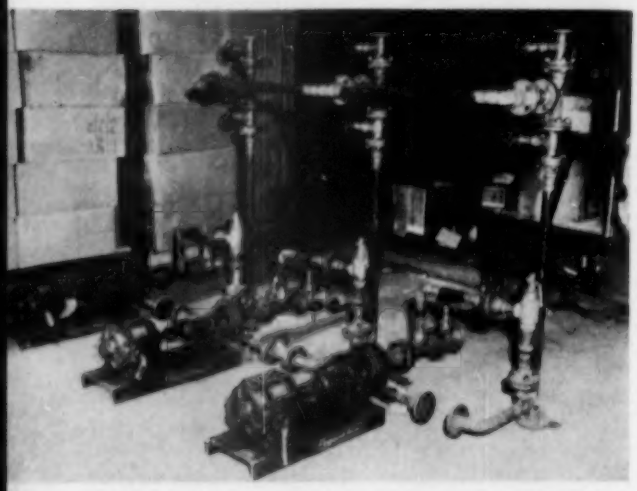


Fig. 9 Group of small oil pumps using $1^1/_2$- and $1^1/_4$-in. Schedule 40 pipe. All butt welded

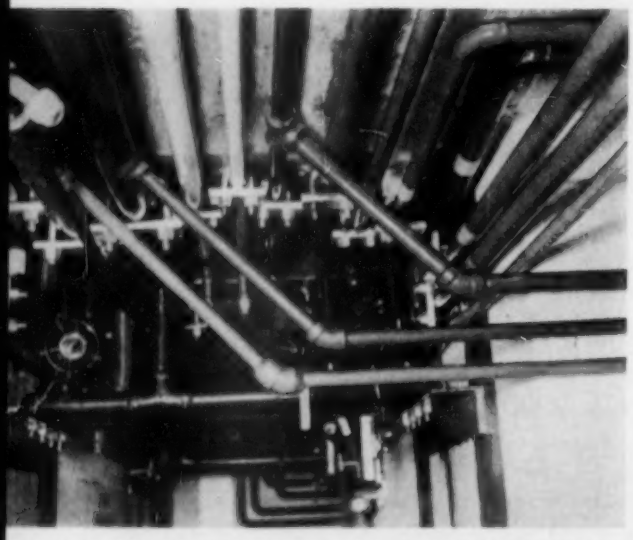


Fig. 10 Hydraulic piping in the oil cellar of a steel mill

On small boiler piping, such as in domestic construction, on compressed air piping, and many other types, the labor time for welding is essentially the same as for threading. But when the contractor tests his pipe he plans on some leaks in the threaded piping, which must be tightened before the system goes into operation. He also knows that in some instances he will have to repair leaks after the system goes into operation. Sometimes he has to take out two or three or more fittings before he can get to a union. Sometimes he has to recut some of the pipe. By and large, contractors figure from 5 to 10% of their piping labor for that kind of work. Nothing like that is required on welded piping.

Figure 10 shows hydraulic piping in the oil cellars of a steel mill. This pipe was installed under difficult conditions, and in very cramped space. When it was put in service there were no leaks in the welded piping. There were several in the threaded piping, and some of the threaded fittings had to be back welded.

The only two all-welded fire protection systems on which complete information is available for this paper were installed at less labor and material cost than all threaded systems of the same kind. One was a water sprinkler system in a large factory. The other was a dry system at an Air Force Base. The savings, by welding, on each, were substantial.

Citing a thousand other instances, showing a hundred more pictures would only emphasize what has already been cited and shown. It would also take a great deal more time. And the real test of any pudding is in the eating. Welding pipe is the best way to find out that welding pipe is best.

High cost is an excuse for not welding pipe. There are reasons, which often the man making the decision attributes to cost, when they belong elsewhere. The usual reason is the lack of pipe welders, as compared to the ready availability of anyone who can lean on a die and pull on a wrench. The fact that threading labor is commoner, in both senses of the work, sometimes makes a contractor or maintenance superintendent think threading pipe is cheaper or easier. It is neither. This line of thought could be followed by saying it is cheaper and easier to walk to the next town because everyone has feet. But the fact is that almost anyone can learn to drive a car and cars are easily obtained.

Conclusion

Probably no one needs to be shown that welding is the cheapest as well as the easiest method of joining steel pipe. That is, if one can weld, welding is the least costly and the simplest method of joining pipe. The average man needs to be shown that he, individually or collectively, can weld pipe. Then he will see for himself that butt welding is the most economical and efficient pipe joining method known today.

WELDING REPAIR COSTING $600 RECLAIMS $8000 ENGINE BLOCKS

BY H. C. WAUGH

Introduction

A metal-arc welding procedure, using 55/45 nickel iron electrodes, has enabled Marine Industries, Ltd., Sorel, Quebec, to effect substantial savings in diesel engine maintenance costs. Marine Industries, Ltd., operates a fleet of diesel-powered towing tugs (Fig. 1) and tankers, mostly in the St. Lawrence River and Gulf and along the Atlantic Coast. Formerly they replaced engine blocks with corroded or cracked guide rings at a cost of about $8000 each. Salvaging the blocks by welding costs an average of $600, a saving of about $7400 per block. Since the welding procedure was first developed, about four years ago, the company has repaired 23 engine blocks, with a total saving amounting to over $150,000.

Repair Problem

The engine part requiring welding is the guide ring—a narrow circular shoulder inside the engine block near the top of each cylinder. The guide ring forms the top of the cooling water jackets and also supports the removable cylinder sleeve or liner.

H. C. Waugh is associated with Technical Service, The International Nickel Co., Inc., New York, N. Y.

Fig. 1 One of the fleet of diesel-propelled tugs operated by Marine Industries, Ltd. Engine cylinder blocks, once discarded because of corroded guide rings, are now salvaged by repair welding

After the engines have been in service for some time, the salt cooling water pumped through the water jackets corrodes the guide ring and destroys the important watertight seal. The water enters the combustion chamber, putting the engine out of commission. Some-

Fig. 2 Piston, head and liner have been removed from cylinder at left. Welding is done in the ships' engine rooms without removing the blocks

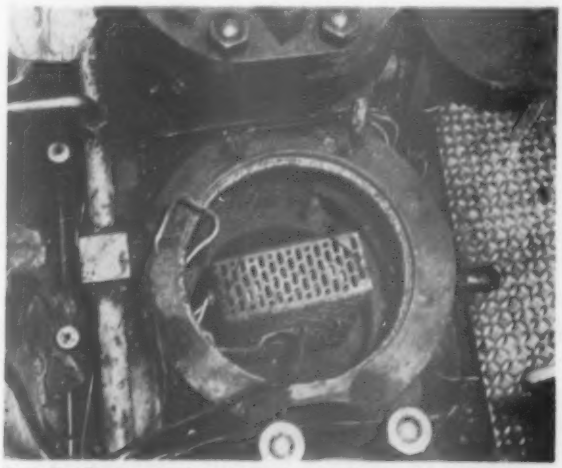


Fig. 3 Resistance heating element is position inside the cylinder. Element is supported at a height just below the guide ring area

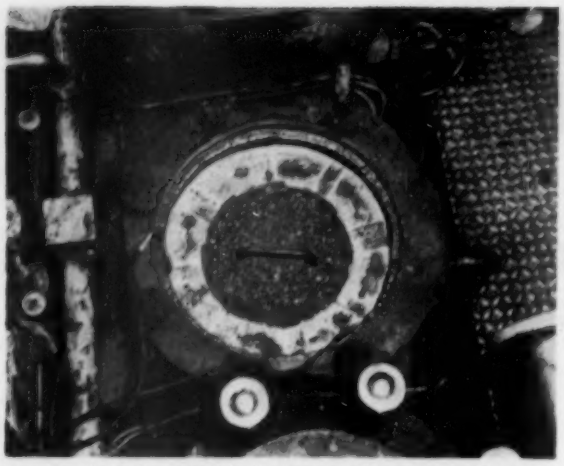


Fig. 4 Heat is sealed in by means of an expanding ring forced tightly against the sides of the water jacket. Valve ports are also blocked off with asbestos packing to retain the heat

Fig. 5 Using 55/45 nickel-iron electrodes, welder deposits and peens each bead individually. Beads are staggered throughout welding operation

times, also, the guide ring simply cracks from normal long service. In either case, repair or replacement is necessary.

The diesel engine block is made in three sections, each containing three cylinders. In past years, when the guide ring in one cylinder deteriorated, a whole block section was replaced. The cost, including dismantling and reassembly, amounted to approximately $8000, so the company decided to try reclaiming the blocks by welding.

There were several factors that complicated the welding problem. The guide ring is a comparatively small section, in relation to the mass of the block. Also, it was impractical to remove the blocks and transport them to the welding department. In order to realize substantial savings it was necessary to weld the blocks in position, in the cramped quarters of the ships' engine rooms. To do this, special equipment had to be provided for preheating, and for machining the guide rings after welding.

These problems were not easy to solve, but a welding procedure was worked out which has been standard practice for the past four years. During that time 23 blocks have been welded at an average cost of $600, saving approximately $150,000.

Selection of Welding Procedure

The metal-arc welding process was selected for this application. A preheat of 600° F was considered desirable in view of the heavy section of the block. A coated nickel-iron electrode with a 55% nickel/45% iron core wire was chosen to meet the exacting requirements of this job. This electrode produced machinable weld deposits and resulted in sound, crack-free welds on the cast-iron cylinder blocks.

The welding technique called for depositing beads of weld metal alternately on opposite sides of the guide ring, and peening each bead individually.

Fig. 6 This close-up view shows the rebuilt guide ring before machining. The nickel-iron weld deposit is readily machinable

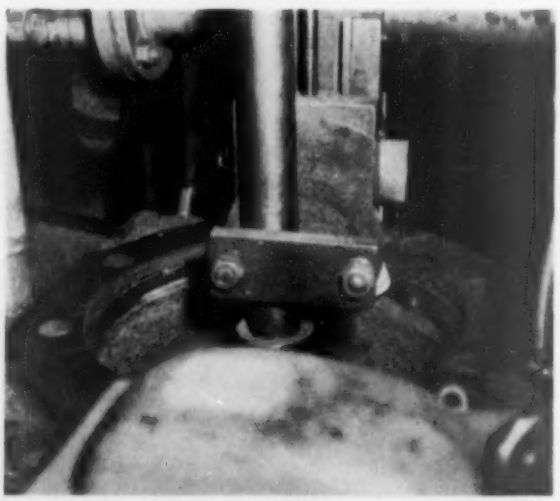


Fig. 7 Guide rings are machined down to final dimensions with special grinding equipment brought to the ships' engine rooms

Fig. 8 The completely rebuilt and machined guide ring. This cylinder is as good as new again, and ready for another long period of service

The step-by-step procedure used in repairing the guide rings at Marine Industries, Ltd. (Figs. 2 through 8) is as follows:

1. Piston, cylinder head and cylinder liner are removed to expose the guide ring area.

2. Remnants of the old corroded guide ring are ground smooth and all dirt carefully removed.

3. An electric heating element of the resistance type is inserted in the cylinder and supported in position just below the guide ring area.

4. A loose cover is placed over the heating element, and an expansion ring immediately above the cover is tightened against the water jacket wall, to keep all heat inside the cylinder. Openings such as intake and exhaust valve ports are sealed with asbestos packing.

5. Temperature is slowly brought up to 600° F. This temperature is maintained in the block during the welding operation.

6. Using the 55/45 nickel-iron electrodes, the welder deposits a single bead, about one inch long, removes the slag and peens the bead. In order to equalize stresses, he deposits the next bead on the opposite side of the guide ring, and again peens. He continues in this manner, placing the third bead halfway between the first two. This staggering of weld deposits is followed throughout the whole welding operation. The rings are gradually built up in this way until the weld is slightly oversize to allow for subsequent machining. The maximum buildup required is $^{7}/_{8}$ in. thick by $1^{1}/_{4}$ in. wide.

7. Six to eight hours are allowed for the gradual cooling of the weldment.

8. Portable grinding equipment is then brought up and the rebuilt ring machined down to correct final dimensions. This operation, like the welding itself, is completed with the block still in position in the engine.

After reassembly, the individual cylinder is as good as new again and the block is restored for another long period of useful service.

Acknowledgment

The author wishes to thank the Canadian Liquid Air Co., Ltd., Montreal, P. Q., Canada, for supplying the illustrations for this article.

PRODUCTION OF REFRIGERATOR INNER LINERS SPEEDED BY MASH-SEAM WELDING

Major cost savings have been achieved in production of refrigerator inner liners. Design of this liner enables use of a special resistance welder which produces a completely welded liner in one operation. Prior conventional liners required six seam welds; now, three mash-seam welds are sufficient.

Ample flange widths enable elimination of later manual "corner" welding. One welding operation replaces the four operations previously required.

A total of eight operators are required on this liner line, in contrast to the 20 operators previously necessary. Two-thirds of welder output is sufficient to maintain line production rate of 90 assemblies per hour.

The welder features dual welding heads making series and indirect welds. Back and bottom welds are simultaneously welded with overlap to produce gas-tight corner welds (see Fig. 1). Welding mandrel rotates 90° to facilitate loading and unloading operations.

Based on a story by Taylor-Winfield Corp., Warren, Ohio.

Fig. 1 Operator at right is shown with welded liner, while operator at left is loading parts on resistance welder

REDESIGNED CORN SHELLING MACHINES USE END-WELDED STUDS AS TEETH

Redesign using end-welded studs increased machine output as much as 200%, cut production costs 50% and proved the feasibility of an entirely new model that opened up a hitherto untouched market.

This series of benefits resulted when granular flux-filled studs replaced the square upset rivets that had been used for 50 years as teeth on cylinders in the Triumph corn shelling machines made by the C. O. Bartlett & Snow Co., Cleveland.

The shift to studs was much more than a simple substitution for rivets, however. Tests proved that far fewer studs than rivets were needed on cylinders, primarily because studs of hardened stock (Rockwell 12-15) could be used and these were superior to plain steel rivets in resisting wear and breakage. (Hardening of rivets was not practical.) The tests also showed that with fewer cylinder teeth, arranged in a somewhat different pattern, many more corn ears were accommodated at a time in a cylinder enclosure and thus the machines' processing capacity was increased. The cylinder teeth agitate and tumble the ears as they come

Based on a story by Nelson Stud Welding Division, Gregory Industries, Inc.

Fig. 2 As this picture shows, the number of studs, illustrated on half a cylinder at right, is much less than the number of rivets formerly needed. Because the studs are made from hardened stock, they prove superior to the plain steel rivets in resisting wear and breakage

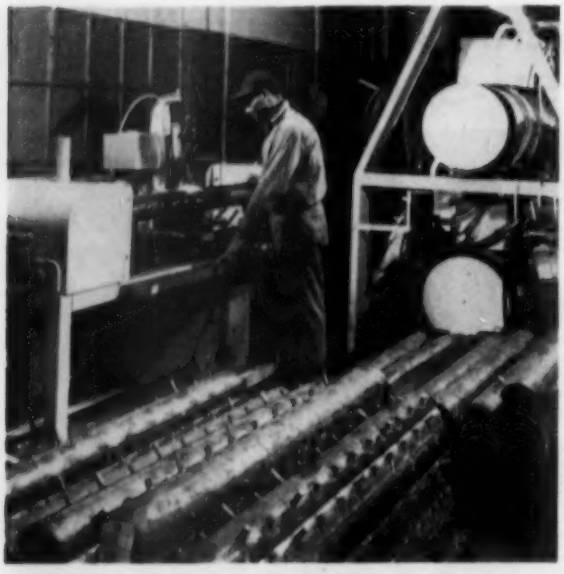
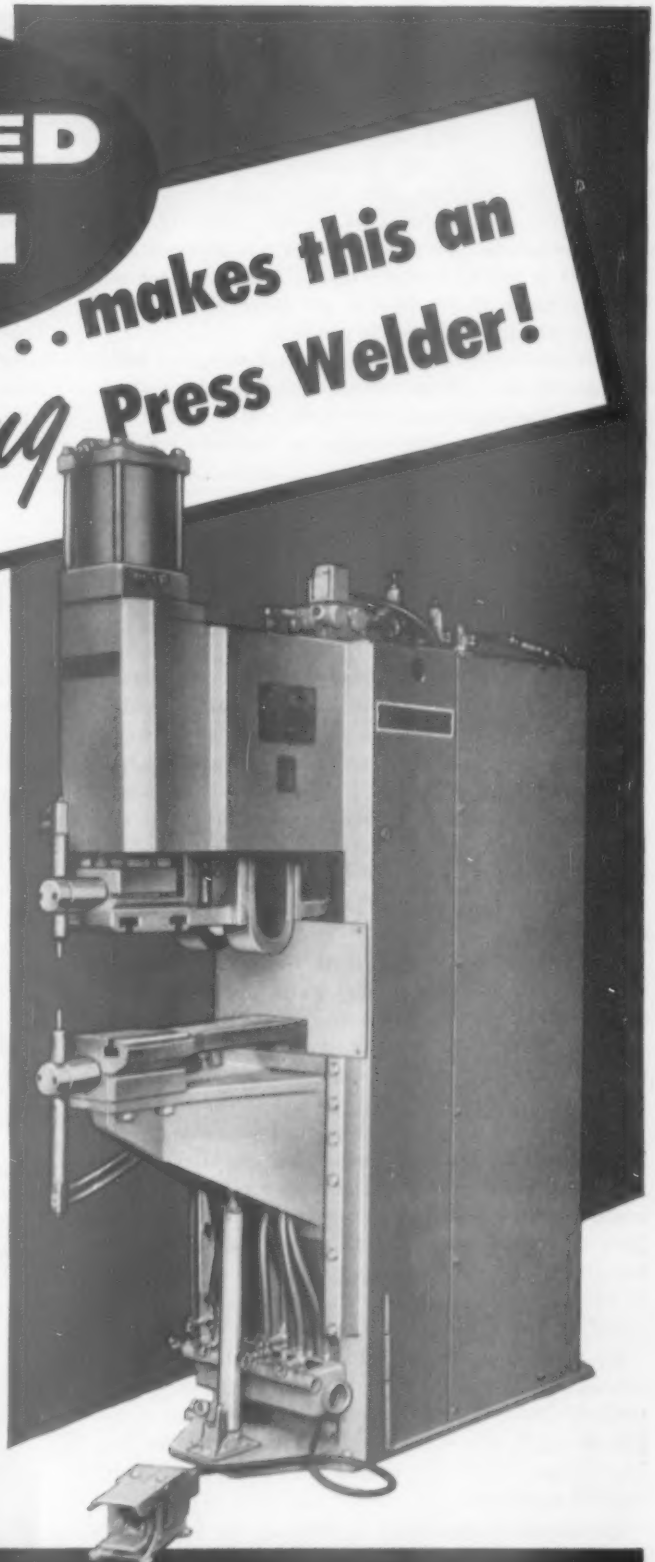


Fig. 1 Studs being end welded at the approximate rate of one every five seconds on special semiautomatic positioning machine, which rotates the cylinder after a stud has been welded and also advances the stud welding production unit along the cylinder

Fig. 3 Operator running down a nut which will secure the housing of the cylinder enclosure, within which ears are tumbled and kernels are removed as the cobs rub together

ADVANCED DESIGN

..... makes this an *Outstanding* Press Welder!



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from the feed hopper, and the kernels are removed as the cobs rub together.

Formerly, there were 160 rivets, spaced $1^3/_4$ in. apart in six rows, on the cylinder in the smallest corn sheller. With redesign of the cylinder teeth, there are only 44 studs, spaced 4 in. apart in four rows. On a larger machine 322 rivets were replaced by 90 studs.

Productionwise, the smallest machine, formerly rated at 100 bushels of corn per hour, now has a capacity of from 200 to 300 bushels per hour. A larger machine, formerly rated at 300 bushels per hour, now handles between 400 and 500 bushels per hour.

A semiautomatic unit enables operators to end weld studs at the approximate rate of one every five seconds, including loading a stud and ferrule. After a stud has been welded, the machine rotates the cylinder either a quarter or an eighth turn, depending on the cylinder size, and also advances the stud welding gun along the cylinder. The stud teeth are thus welded in a perfect spiral pattern.

Not only are the stud teeth installed for less than 50% of the former cost of attaching the rivet teeth, but the presses formerly needed with the rivets have been released for other work.

Studs used in this application are $^1/_2$-in. in diameter, and $^7/_8$- and $1^5/_8$-in. long. Before teeth are welded to a cylinder, the operator stacks the studs in holes in a board in front of the positioning machine. The two sizes of studs are stacked with the aid of different-colored holes, so that as studs in a row are used in order, from left to right, the desired size is always welded at the right spot on the cylinder.

UNUSUAL FIXTURES FACILITATE WELDING

The special iron cast fixtures installed in a special pneumatic press (Fig. 1) now make it possible to tack weld manifolds for aircraft engines with unprecedented speed and precision at Ryan Aeronautical Co., San Diego, Calif.

The fixtures are castings which were made by Lincoln Foundry, Los Angeles. The castings look something like conventional female forming dies, and two are needed to align the components of a manifold with any given design.

When they were initially used, the fixture components were respectively mounted on the upper and lower platens of a hydraulic press. Good results were thus obtained, but it was immediately apparent that there was no need to tie up an expensive machine tool in order to get the job done.

Consequently, Ryan developed the pneumatic press—a relatively simple and inexpensive machine with a stationary lower platen and an upper platen which is readily actuated by air pressure. Little pneumatic power is required to operate this press because the only compressive force it brings to bear on a workpiece is due to the weight of an iron tooling component and the upper steel platen to which it is attached.

Heat-resistant manifold halves fixtured by the tooling cannot possibly be misaligned as long as the pneumatic press is closed. Yet, due to the configurations of the high-strength iron castings, all manifold surfaces that must be tacked are fully accessible to workers using arc-welding equipment.

Distortion is minimized in making the tack welds (Fig. 2) because these iron fixtures tend to absorb heat—thus limiting heat-affected areas on the manifold components.

Based on a story by the Mechanite Metal Corporation, New Rochelle, New York.

Purpose of the tack welds in each instance is to maintain the alignment of manifold halves so that the latter can be inert-gas tungsten-arc welded with optimum speed and precision.

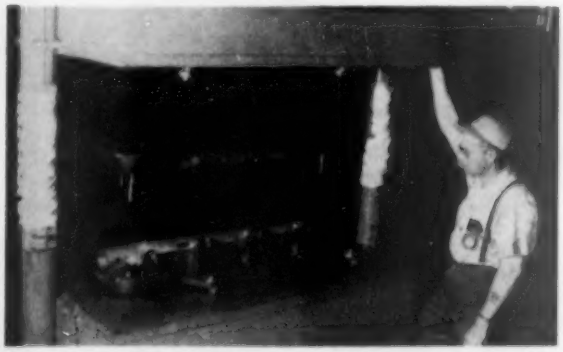

Fig. 1 Special pneumatic press with processed cast-iron welding fixtures is shown here in the open position, immediately prior to the removal of tack-welded manifold components

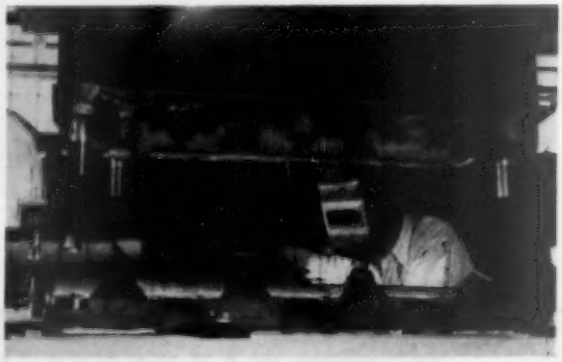

Fig. 2 With manifold components positioned on welding fixture, as illustrated here, the pneumatic press is closed so that tack welding can take place

Society News

Welding of Precipitation-Hardening Stainless Steels to Be Subject of Adams Lecture at Fall Meeting

George E. Linnert, head of the welding research group in the Armco Steel Corp. Research Laboratories, has been selected to deliver the 1956 Adams Lecture during the Fall Meeting of AWS to be held October 8th to 12th in Cleveland. His paper will cover the timely subject, "Welding of Precipitation-Hardening Stainless Steels." The lecture will be delivered during the Monday morning Honors Session.

Because the use of precipitation-hardening stainless steels in high-strength, corrosion-resisting products is growing rapidly, there is widespread need for information about the methods of welding and fabricating these materials. Mr. Linnert's paper will help fill this need. It covers the metallurgical structure of the four major types of precipitation-hardening stainless steels and presents details on their weldability, heat treatment, and welding procedures.

Papers covering practically all phases of welding activity will be presented at 21 technical sessions to be held during the five-day meeting. A number of the papers will report on latest methods and techniques for welding some of the relatively new commercial metals and alloys, such as titanium, zirconium, arc-cast molybdenum and magnesium-thorium alloys. The program includes two special sessions—a symposium on metallizing arranged by the AWS Committee on Metallizing and a session on welding shop management.

Other sessions will cover weldability and research; welding of structures and aircraft; inert-arc welding; resistance welding; brazing; and welding of piping, tubing and pressure vessels.

Other events to be held during the meeting include the President's Reception, two plant tours, a series of educational lectures and a national dinner.

The AWS Fall Meeting will run concurrently with the National Metals Exposition at which welding and cutting exhibits and demonstrations will be shown.

AWS DIRECTORS-AT-LARGE

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	J. W. Mortimer	E. D. Peters	G. E. Linnert
	Hal Savage	J. L. Wilson	Gordon Parks
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Junior Past-President	C. H. Jennings	Junior Past-President	J. H. Humberstone

Coming Along Fine!

On June 14 our National Secretary, Joe Magrath, encountered a temporary setback in the form of a coronary occlusion. You will be happy to know that his recovery is progressing very satisfactorily. He will soon begin to reassume his duties.

1956–1957 National Nominating Committee Formed

The recently constituted National Nominating Committee for the 1956–57 fiscal year includes the following members:

Chairman—J. H. Humberstone, President, Air Reduction Sales Co., 150 E. 42nd St., New York 17, N. Y.

District Representative Members—District 1 (New England): E. F. Nippes, Director of Welding Research, Rensselaer Polytechnic Institute, Troy, N. Y.

District 2 (Middle Eastern): J. Naab, Engineer in Charge, Compressors, Ingersoll Rand Co., 132 Parsons, Easton, Pa.

District 3 (North Central): W. F.

Buchanan, Foreman of Welders, Copper, Bessemer Corp., Lincoln Ave., Grove City, Pa.

District 4 (Southeast): R. E. Lorentz, Metallurgist, Combustion Engineering, Inc., 306 Crestway Dr., Chattanooga, Tenn.

District 5 (East Central): H. B. Cary, Welding Superintendent, Marion Power Shovel Co., Marion, Ohio

District 6 (Central): J. R. Stitt, Research & Welding Engr., R. C. Mahon Co., Box 4666, Detroit 34, Mich.

District 7 (West Central): W. L. Palmer, Industrial Engineer, Deere & Co., 3300 River Dr., Moline, Ill.

District 8 (Midwest): N. Stueck, Assistant Secretary, Stupp Brothers Bridge & Iron Co., Box 24, Lemay 23, Mo.

District 9 (Southwest): W. H. Greer, Asst. District Manager, Southwestern Laboratories, 1103 Chartres, P. O. Box 175, Houston 1, Texas

District 10 (Western): D. Tillotson, Manager, Aweco Supply Co., 800 S. Park Ave., Tuscon, Ariz.

District 11 (Northwest): D. C. Christofferson, Welding Engineer, Chicago Bridge & Iron Co., 3676 S. 2000 W., Salt Lake City, Utah

Members at Large—H. Jackson, Plant Superintendent, Thompson Pipe & Steel Co., Larimer and 30th Sts., Denver, Colo.; I. A. Oehler, Manager of Manufacturing, American Welding & Manufacturing Co., Dietz Rd., Warren, Ohio; F. L. Plummer, Director of Engineering, Hammond Iron Works, Box 660, Warren, Pa.

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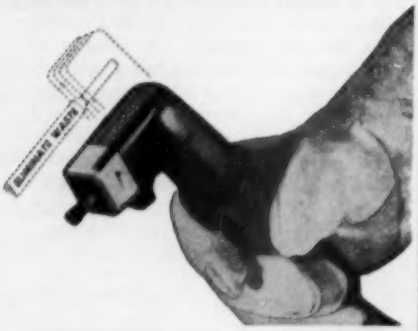

The jaws substitute for stub waste by splicing a 2 inch extension to the length of every electrode.

"Multi-Pic" CONTOUR CLEANER

Delivers FIVE surface cleaning blows with each swing and lasts FIVE times longer than single headed hammers.

"Pro-Clamp" MECHANICAL HANDS

MODERNIZE the fabrication of plates, shapes, rods, bars, pipes, etc. MAKE fitting, positioning, holding, and welding a fast, accurate, inexpensive, one-man job.

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Maryland Adopts Z49

The Department of Labor of the State of Maryland has recently adopted *Safety in Electric and Gas Welding and Cutting Operations* as regulations with the force and effect of law, governing welding operations. This publication is American Standard Z49.1 and was prepared under the sponsorship of the American Welding Society.

In commenting on this, Joseph A Haller, Director of Safety of the Maryland Department of Labor and Industry, stated: "Our Safety Advisory Board felt that this was an excellent standard and recommended its adoption to the Commissioner of the Department of Labor and Industry." Continuing, Mr. Haller stated: "We have felt for some time that it is better to adopt standards or codes national in scope than it is to compile codes of our own." Standards, approved by the American Standards Association, meet our requirements very well in this respect and a total of 34 such Standards have been adopted and issued for use in Maryland. Also American Standards, prepared by a Committee of experts representing all interested parties, carry more weight in obtaining compliance than regulations arbitrarily issued by a regulatory department of the government.

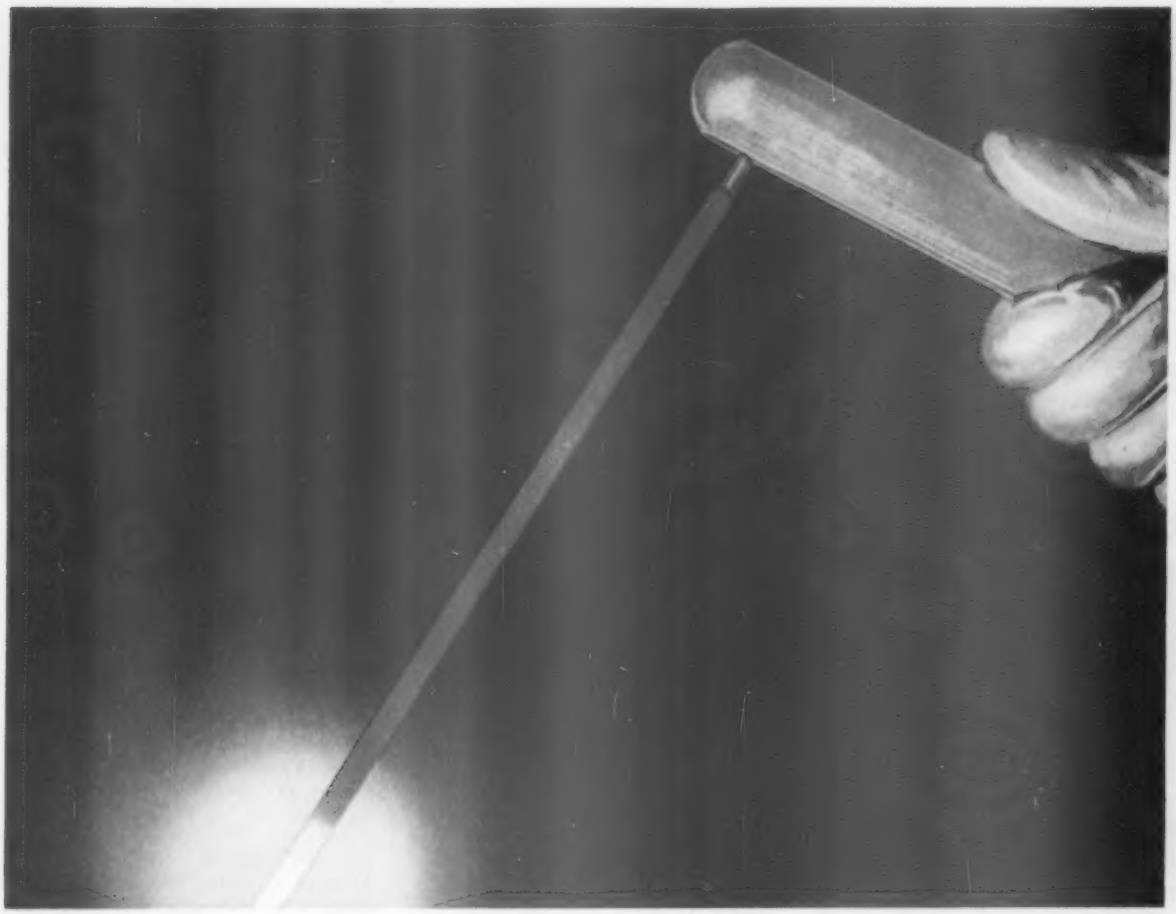
This is reported as another example of the value of standards prepared by well-qualified experts on a national basis through organizations such as the American Welding Society and the American Standards Association.

Outlook for 38th Annual National Metal Congress Is Excellent

All 350,000 sq ft in Cleveland's Public Auditorium and Exhibition Hall will be occupied by exhibitors at the 38th Annual National Metal Congress and Exposition which returns to the shores of Lake Erie for the tenth time, Oct. 8–12, 1956.

Concurrent with the Metal Show, the National Metal Congress will hold scientific sessions in four headquarters hotels. Participating in the Congress with the American Society for Metals (headquarters—Hotel Statler) are the American Welding Society (Hotel Cleveland), the Institute of Metals Division of the American Institute of Mining, Metallurgical and Petroleum Engineers (Hotel Carter), and the Society for Non-Destructive Testing (Hotel Hollenden).

Some 150 technical papers will be presented during the week in special sessions conducted by each of the cooperating societies.



Fabricator welds 5 dissimilar alloy combinations with Inco-Rod "A"

Proves electrode's versatility

Time after time, Inco-Rod "A"* proves successful in welding dissimilar alloy combinations.

Think of the *variety* it welds for just one fabricator.

In producing evaporators, this company joins 2¼% Chromium—1% Molybdenum Steel to 347 Stainless. Inco's Technical Service representative reports: 'good fusion and sound welds are obtained. Operator likes the way Inco-Rod "A" handles.'

In distilling equipment, they weld 1020 Carbon Steel to 70/30 and 90/10 Copper-Nickel Alloy. The report: 'Inco-Rod "A" gives excellent results . . . good bead appearance and fusion . . . no porosity or cracking.'

Results are similar in welding SA-266 carbon steel to 70/30 Copper-Nickel and Monel* nickel-copper alloy for a heat exchanger. 'Better arc control than with previous electrode . . . pin holes are reduced about 80%.'

But successful welds are not surprising with Inco-Rod "A" . . . the new electrode with the distinctive *green* flux coating. It welds *most* dissimilar alloy combinations . . . both between and among ferritic and austenitic stainless steels, low alloy steels, mild steels, high nickel alloys, and other alloys.

Welds are strong and ductile . . . of X-ray quality. Corrosion resistance usually equals or exceeds that of the base metal. And operability is excellent in any position . . . spray type arc . . . easy slag removal.

Are *you* having trouble welding dissimilar alloys? Chances are good that Inco's Technical Service can help you. Write us giving details.

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INCO-ROD "A" electrode is supplied in 14-inch lengths in four diameters, 3/32-, 1/8-, 5/32- and 3/16-inch (the 3/32-inch is center grip) packed in 5-lb. containers (NEMA color coded).

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Section News and Events

as reported to Catherine O'Leary

BUSINESS MEETING

Fort Wayne, Ind.—Thirty members and guests of the *Anthony Wayne* Section met for dinner and a short business meeting on June 7th at the Ranch Hobby House.

Coffee speaker was R. Nelson Snider, Principal of South Side High School. Mr. Snider gave an interesting and enlightening discussion of what is humorous and why it is humorous.

A travelog on the Hawaiian Islands in color and sound was shown through the courtesy of United Airlines.

OFFICERS HONORED BY ANTHONY WAYNE SECTION

D. B. Rice being presented with past-chairman's pin by K. Zimmerman at June 7th meeting of Anthony Wayne Section

D. Clark giving the returns of the election to the new Section chairman, J. R. Geiser

ANNUAL WELDING SYMPOSIUM

Cleveland, Ohio.—One of the highlights of the 17th Annual Welding Symposium, sponsored by the *Cleveland* Section, was its dedication to Irving B. Hexter, publisher of *Industry & Welding* and *Welding Illustrated*.

Awarded annually, the symposium dedication is the highest tribute which can be paid by the Section to one of its members. In making the symposium dedication, Allan Stern, outgoing chairman of the Cleveland Section, cited Mr. Hexter as a person of great distinction in the community as well as in the welding industry. In his reply, Mr. Hexter thanked the group and reminisced for a few minutes about the progress of welding. His optimistic remarks about the future of the industry were received with great interest.

The symposium this year was a stimulating, informative 12-hr session, bigger—and in some respects better—than ever before. It was the result of the teamwork and careful planning of a highly developed organization of the Cleveland Section members.

As in previous years, the symposium attracted a large following. More than 700 welding specialists, executives, scientists and production authorities were in attendance during the day-long conference. They heard nationally known technical speakers discuss important new developments in welding.

More than 500 members and guests attended the dinner and heard an illuminating address by Everett A. (Rusty) Sisson, sales manager of Osborn Manufacturing Co. Mr. Sisson—who was also toastmaster—introduced the principal speaker of the evening, the Rev. Laurence Hall, an accomplished philosopher and humorist. Mr. Hall enthralled his audience with his gems of humor. He was rewarded with a standing ovation.

Another high point in the evening's activities came when members honored both Jack Jarms of the Harnischfeger Corp., Milwaukee, Wis. and William E. Mumford of Diebold Engineering Sales Co., Cleveland, Ohio, with meritorious awards. The award was made to Mr. Jarms for his outstanding service as a former officer and chairman of many committees of the Cleveland Section. Mr. Mumford's citation was for having assisted on various committees in such a way as to expand the usefulness, influence and prestige of the Section.

Another outstanding feature of the Symposium this year was the expansion and further refinement of the educational displays.

An award for the best educational exhibit was made to P. R. Mallory & Co., Inc.

Authors of the technical papers were: Robert A. Noland of the Argonne National Laboratory, who spoke on "Welding Problems in Nuclear Reactors"; Frank J. Bockhoff, American Agile Corp., who covered "The Welding of Plastics" and Roy W. Emerson, Pittsburgh Piping & Equipment Co., whose topic was "Welding of Piping and Pressure Vessels for Atomic Energy Applications."

GOLF OUTING

Itusca, Ill.—The *Chicago* Section's annual golf outing was held on June 9th at the Nordic Hills Country Club in Itusca, Ill. Tee-off time began at 7:00 A.M. A good time was had by all—282 attended—and each one went home with a prize.

ANNUAL MEETING

Denver, Colo.—The *Colorado* Section held its annual meeting on June 12th at the Plantation Inn where they enjoyed a fried chicken dinner. Reports were given by H. Jackson, Nominating Committee, and W. D. Hooper, chairman of Membership Committee. The annual report of the section chairman, C. Brinton Swift, was presented, accepted and approved. Installation was then

17TH ANNUAL WELDING SYMPOSIUM HELD BY CLEVELAND SECTION

Allan Stern, outgoing chairman, congratulates Irving B. Hexter to whom the Cleveland Section dedicated its 17th Annual Welding Symposium

Seated at one end of speaker's table are (*left to right*) C. T. Elder, secretary-treasurer elect; R. Noland, technical speaker; L. Gilbert, District 5 director-elect; A. Portz, chairman-elect; William Mayor, first vice-chairman-elect, and E. Sisson, toastmaster

Pete Sawyer, Cal Wyss, Clayt Herrick and Tom Elder (*left to right*) are shown in discussion at the Symposium

At one of the many featured exhibits, Herb McCoy explains positioned welding to a guest

This carefree group includes John Wolfender (*center*) and Bob Kriz, retiring secretary-treasurer (*right*)

completed of the following officers: Edward O. Browning, chairman; C. E. Withers, vice-chairman; Edmund J. Berens, secretary-treasurer.

The members then proceeded to the new research laboratory of the Ohio Oil Co. where they were given a preview of this outstanding facility. This closed the activity of the Colorado Section for the year 1955–56.

EXECUTIVE COMMITTEE MEETING

At the first executive committee meeting for the 1956–57 season the following officers of the *Detroit* Section were installed in their respective capacities: Chairman, Bill Smith; Vice-Chairman, Gordon Kirkwood; Second Vice-Chairman, Larry Kendall; Secretary, Ray Wolgast; Treasurer, Ray Stitt; Assistant Secretaries, Art Brown, Bob Burch and Ray Wilcoxson.

Chairman Smith presented Jim Rainey with his past-chairman's pin, and Ray Stitt received a clock and set of carving knives in recognition of his several years of work as Secretary-Treasurer.

The dates for the monthly programs were set starting with the first meeting on Sept. 21, 1956, and ending with the last program on May 18, 1957.

HOUSTON SECTION ELECTION

Houston, Tex.—Officers and directors of the *Houston* Section for 1956–57 were announced as follows: chairman, P. D. Morgan, Industrial Welding Equipment Co.; first vice-chairman, Roy P. Pringle, Air Reduction Sales Co.; second vice-chairman, W. C. Cox, General Electric Co.; Secretary-treasurer, Malcolm Avis, General Welding Works, Inc.; assistant secretary-treasurer, Don Middlehurst, Big Three Welding Equipment Co.; directors—elected for two years, James Earthman and Victor A. Thompson.

PAST-CHAIRMEN's NIGHT

Cumberland, Ind.—The May meeting of the *Indiana* Section was held on May 18th at Buckley's Restaurant in Cumberland.

In compliance with the precedent established last year, the May meeting was declared Past-Chairmen's Night. Several past chairmen were present.

A tasty chicken dinner was enjoyed by all, after which a very good presentation on "Silver Brazing" was given by Carl J. Saks [illegible], manager of the Silver Brazing Alloys Division of the Goldsmith Brothers Smelting and Refining Co., of Chicago, Ill.

Mr. Saks discussed the properties, application and brazing characteristics of the various low-temperature brazing alloys. Design of assemblies for brazing, fit-up and method of placing brazing material was covered. Heating methods were discussed.

The election of officers was held for 1956–57 with the following results:

AIRCRAFT AND ROCKETRY PANEL ADDRESSED BY MEREDITH

Members and guests in attendance at the concluding meeting of the Aircraft and Rocketry Panel of the Los Angeles Section on June 7th

Panel-Chairman Harlan Meredith presented paper on "Techniques of Welding Thin Metal"

Dick Hayes and the charming Mrs. Raymond Bisch prepare to draw the door prizes

Michael G. Schaefer, chairman; Edman F. Holt, first vice-chairman; Karl P. Shetterly, second vice-chairman; Fred Watts, treasurer; Mercedes Spotts, secretary.

WELDING THIN MATERIAL

Huntington, Calif.—The June meeting of the Aircraft and Rocketry Panel, *Los Angeles* Section, was held on the 7th at the Elk's lodge in Huntington Park, Calif., with an attendance of 173 members and guests. The program featured a semitechnical paper presented by Harlan Meredith, chairman of the Aircraft and Rocketry Panel, and vice-president of Airline Welding and Engineering Co of Hawthorne, Calif.

Mr. Meredith's subject, "Techniques of Welding Thin Material," was prepared and presented in compliance with a request made at the beginning of the Aircraft and Rocketry Panel's 1955 fiscal year by director-at-large Francis Stevenson, production welding engineer, Aerojet-General Corp.

The development work in preparation of Mr. Meredith's paper was conducted at Airline Welding and Engineering Co.

Mr. Meredith took this phase of welding from its original inception up to the present time showing, step by step with the use of slides, the progress made not only in the development of the necessary tooling and equipment required, but also the techniques and processes needed in the successful welding of thin materials.

The results of Mr. Meredith's test work using the automatic tungsten arc inert-gas process established that welding of 0.003 and 0.010 aluminum and stainless steel and 0.015 titanium (AMS 4901) can be accomplished with considerable ease.

Mr. Meredith's paper was delivered in such a manner as to make it quite comprehensible to the welder and still technical enough to be enjoyed by the engineer.

Mr. Meredith served a dual purpose in presenting the evening's program, as he also delivered a very interesting coffee talk entitled "Hunting Elk in Montana's Teton Mountains," a narration accompanied by colored pictures about hunting elk at Hanna's Gulch.

The hunters were handicapped by snowstorms and subzero weather; however, they still got their limit—two truck loads.

Upon conclusion of the evening program Mr. Meredith was presented with a desk pen set as a token of appreciation and as a memento of the occasion.

Prior to the evening's program and upon opening the meeting, which was the Aircraft and Rocketry Panel's last meeting for the fiscal year, Mr. Meredith extended the Panel's greeting to all welding operators present, as this was a meeting honoring the welding operator and, as an inducement for a good turnout, the first 30 welding operators to make reservations were presented with free dinner tickets through the courtesy of Airline Welding.

Prior to the introduction of John Ross, Membership Chairman of the Los Angeles Section, Mr. McGinley, Chairman of the Los Angeles Section, spoke briefly on the outstanding growth of the Section which is now leading the country in both membership and attendance.

Mr. Ross then introduced from the floor the many members who so generously contributed their time and efforts in procuring new members. He also dwelt on the challenge that is being put forth by other sections to meet this outstanding growth.

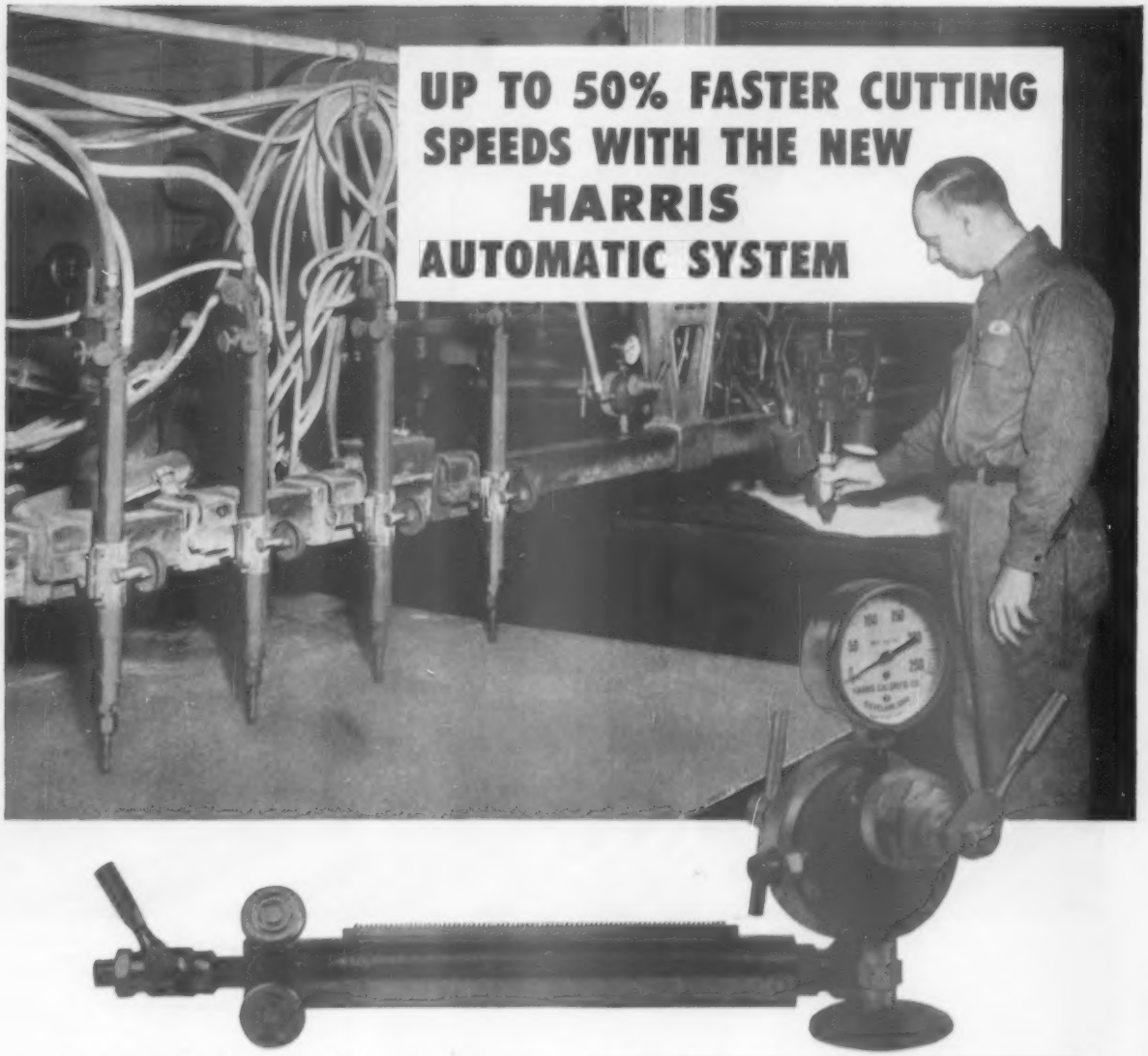
ANNUAL MAY PARTY

Milwaukee, Wis.—The members of the *Milwaukee* Section brought their ladies to the annual May party held on May 19th at the Plankinton Hotel. The affair gave everyone concerned an excellent opportunity to become better acquainted. Excellent food was served with plenty of "good cheer."

After dinner, the past-chairman's pin was bestowed on Joe Stevens and he was warmly applauded for the excellent manner in which he advanced the Milwaukee Section in the past year. The new officers were then installed.

Twenty worth-while attendance prizes were distributed to 20 lucky ladies.

The floor show was put on by Milwaukee's finest entertainers. This was followed by dancing to the music of Grant Krueger's orchestra who also played throughout the dinner.



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Low cost inert gas shield!

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SEATTLE—Phone: Elliott 8252
WEST VIRGINIA
CHARLESTON—Phone: 3-1677
HUNTINGTON—Phone: 3-7144
WISCONSIN
MILWAUKEE—Phone: Broadway 3-6914

SAN FRANCISCO SECTION INSTALLS OFFICERS DURING VISIT TO MARE ISLAND NAVAL SHIPYARD

San Francisco Section group shown during the visit to Mare Island Ways on May 28th. Keel of U.S.S. *Sargo* is in background

Left to right are L. A. Keck, C. B. Robinson (past-chairman), L. Robbins, W. F. Ajello F. Stettner (new chairman), B. P. Faas, S. Roberts, E. R. Babylon and C. W. Doggett

C. B. Robinson, Section chairman, presenting gavel to Fred Stettner, the incoming chairman

C. B. Robinson in the process of receiving the past-chairman's pin from L. A. Keck

The new officers are as follows: Francis J. Harencki, Harnischfeger Corp., chairman; John J. Linnehan, Bentley Sales Co., first vice-chairman; Anton L. Schaeffler, Allis-Chalmers Mfg. Co., second vice-chairman; Robert J. Keller, A. O. Smith Corp., secretary; Wm. J. Dyble, the Heil Co., treasurer.

ANNUAL MEETING

New York, N. Y.—The last meeting of the season of the *New York* Section was held on May 25th in the afternoon primarily for the election of new officers for the coming season as follows: chairman, J. T. Stewart, Whitehead Metal Products Co.; vice-chairman, A. L. Seiden, Architect; 2nd vice-chairman, J. E. Mooney, New York Trade School; secretary and treasurer, G. Metterhauser, Air Reduction Sales Co.

The retiring chairman, John Mikulak, who had done an excellent job of chairmanship throughout the entire

year, turned the gavel over to the incoming chairman, Mr. Stewart.

After the business meeting, the annual dinner was held, with 208 members of the section in attendance.

Following an excellent dinner, the members were entertained by an excellent show of the lighter variety.

This meeting was held at the Building Trades Headquarters at 2 Park Ave., New York City.

LADIES' NIGHT

Olean, N. Y.—Annual election of officers and Ladies Night of the *Olean-Bradford* Section was held at the Castle Restaurant, Olean, N. Y., on June 19th. It was a very enjoyable evening for all 48 members and guests who attended this affair.

Dinner music was provided by a three-piece string ensemble and dancing followed the dinner.

The ladies were provided with beautiful corsages and also tickets for door prizes.

Outgoing chairman Mike H. Robinson paid high tribute to the officers and members who assisted him in a successful year at the helm of the local Section.

WELDING MILD STEEL

Seattle, Wash.—The May meeting of the *Puget Sound* Section was held at the Engineer's Club on May 17th.

The featured speaker of the evening was Roger W. Tuthill [illegible], welding process engineer for the General Electric Co., Welding Department. Mr. Tuthill presented a very lucid description of welding mild steel with the automatic gas-shielded (CO_2) welding process. Mr. Tuthill's speech was introduced as a technical topic but to the pleasure of the audience the speech was held on a level of complete understanding for everyone in attendance.

The officers for the 1956–57 season were elected during the business meeting. The officers for the coming year are William H. Downing, chairman, Frank Johnson, vice-chairman, and Douglas Allan, secretary-treasurer.

INSTALLATION OF OFFICERS' NIGHT

San Francisco, Calif.—The *San Francisco* Section celebrated on May 28th the "Installation of New Officers' Night" by inspecting the naval construction and repair facilities of the Mare Island Naval Shipyard.

Following a movie explaining the yard organization, the members toured the ways and the shops. The U.S.S. *Grayback*, a new submarine being converted into a guided missile submarine, was inspected on the ways. The "keel" of the U.S.S. *Sargo*, the nuclear-powered submarine being built at Mare Island, provided the background for a group picture at the ways.

In the shops, the members were shown the many components of the *Sargo* which were under construction. All were of intense interest and many of exciting interest. It was no small thing, the group agreed, to have the privilege of closely observing the part building of this nuclear ship, looking over the shoulders of welders applying the lead shielding where the fuel units are to be nested for the generation of power. Welding was surely demonstrated at its best in the U.S.S. *Sargo*'s construction and so vital is it to the perfection of every phase of fabrication, it seemed unlikely that the ship would be successfully built without this method of joining. Thus, it appeared that the timetable of welding progress has been coincidently phased in with the progress made in developing nuclear power to make this ship possible.

Other welded items well worthy of mention are the aluminum shop-welded destroyer masts. These complex, tripod, tubular structures, intricate in design and some 50 ft in height, are built of many sizes of tubing and, although they do not lend themselves to jigging, amazing accuracy is maintained in alignment and dimensions during the welding.

SOCIAL MEETING

San Jose, Calif.—A social get-together was held as a final meeting of the season for the *Santa Clara* Section on May 29th at the Almaden Golf and Country Club. Some 125 members and their ladies helped to make this a very successful meeting and close out a highly successful year.

Following the dinner, students from the Drama Department of San Jose State College presented a 30-min skit from "The King and I."

Dancing was held from 10:00 P.M. to 1:00 A.M.

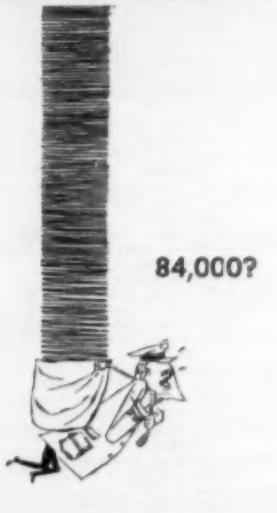
The following new officers for 1956–57 were installed: Fortune Masdeo, chairman; Michael Sebastian, 1st vice-chairman; Dolph Hubbard, 2nd vice-chairman; Ron Skow, treasurer; Jack Garrels, secretary.

STEEL PLANT TOUR

Lone Star, Tex.—The June meeting of the *Shreveport* Section featured a most successful plant tour of the Lone Star Steel Co., Lone Star, Tex. Some 45 members attended the tour on June 16th which was arranged by the program chairman through Robert Collins, public relations manager of Lone Star. Mr. Collins gave a brief talk in the cafeteria where refreshments were served prior to the tour. The party saw the iron ore mines, coke furnaces, open-hearth furnace and welded pipe plant. The tour started at 2:15 and ended at 4:45 P.M.

INSTRUCTIONS FOR PROSPECTIVE AUTHORS

Authors who plan to submit papers for publication in THE WELDING JOURNAL are invited to send for a free copy of the booklet "Instructions and Suggestions for Authors." All requests should be addressed to Editor, THE WELDING JOURNAL, American Welding Society, 33 W. 39th St., New York 18, N. Y.



Yes . . . in a 12-month period from January 1955 to December 1955, 84,000 reprints of vital articles in The Welding Journal were requested . . . . proof of the authoritative editorial calibre of The Welding Journal. Proof, too, of the acceptance by the welding and allied industries of The Welding Journal's high standard of reporting.

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- Can bend the volt-ampere curve to meet the particular welding job being done.
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- Can strike an arc without the use of high frequency when using inert gas and tungsten on extremely low current.
- Exclusive, patented Magnetic Amplifier combines fine control with ruggedness and durability.
- Exclusive, *dual* remote control equipment available ...provides close control of complete current and voltage range.
- Low spatter performance on special electrodes.

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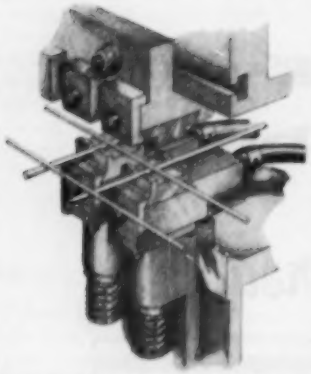
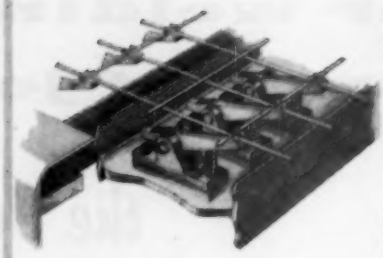
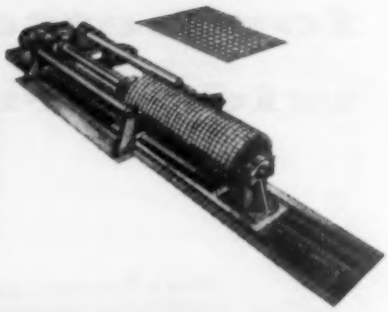


UNITIZED CONSTRUCTION of welding heads simplifies adjustment for mesh spacing and facilitates removal for maintenance. Up to 160 heads may be used.



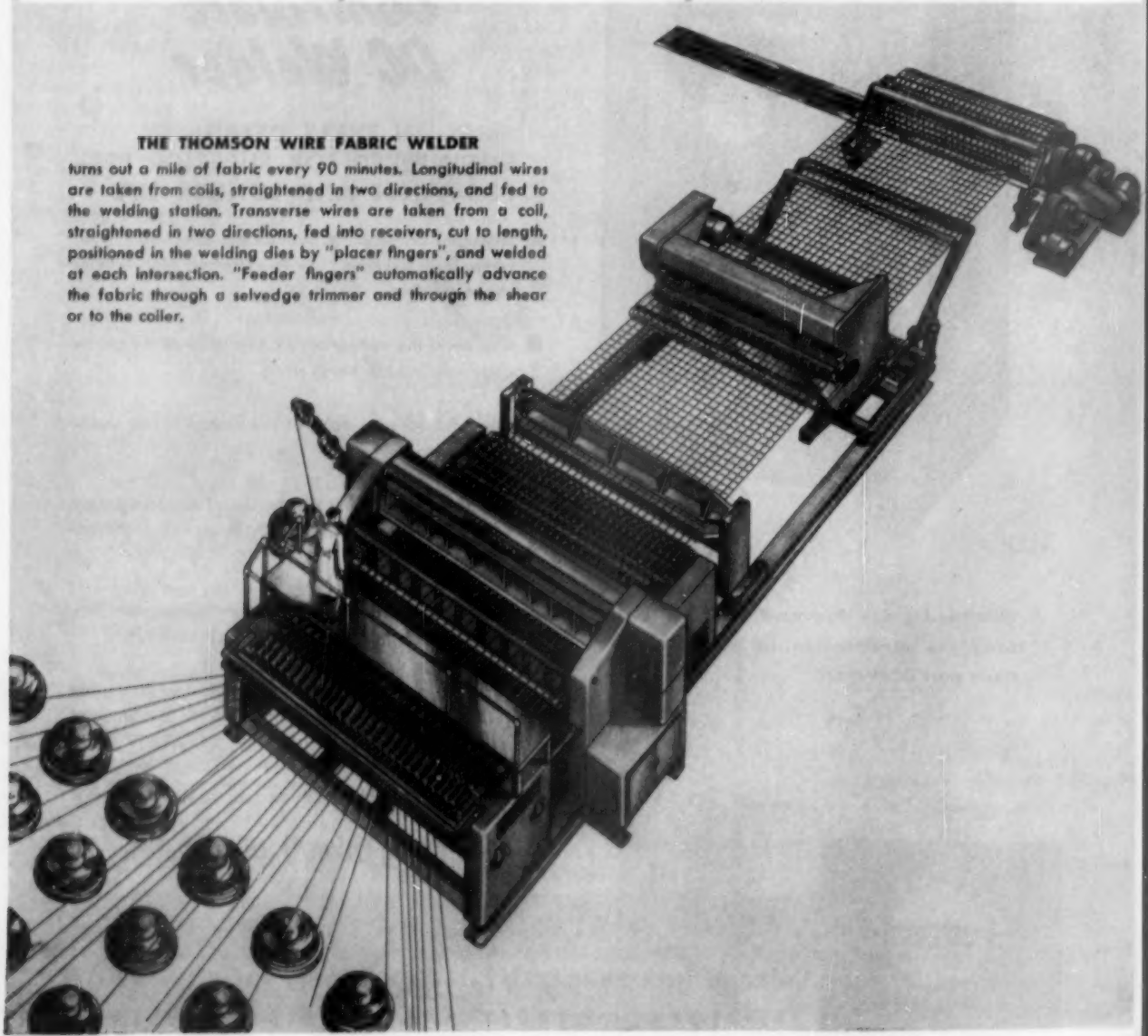
FEEDER FINGERS advance the fabric between each series of welds. Position of the two sets of fingers is adjustable to suit the mesh spacing.



COIL UNLOADING is automatic. A full coil is shown moving out on the cradle which is designed for rapid unloading to permit continuous operation of the welder.

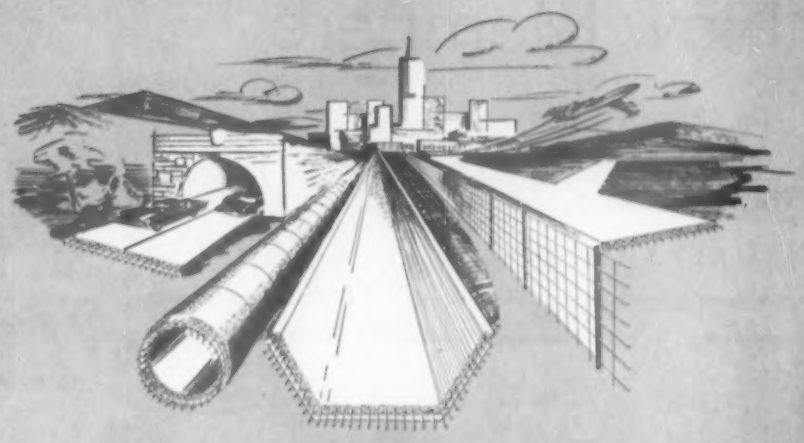
THE THOMSON WIRE FABRIC WELDER

turns out a mile of fabric every 90 minutes. Longitudinal wires are taken from coils, straightened in two directions, and fed to the welding station. Transverse wires are taken from a coil, straightened in two directions, fed into receivers, cut to length, positioned in the welding dies by "placer fingers", and welded at each intersection. "Feeder fingers" automatically advance the fabric through a selvedge trimmer and through the shear or to the coiler.



EVERYDAY USES OF WIRE FABRIC

Welded wire fabric is used to reinforce concrete highways, streets, sidewalks, floors, roofs, walls, beam wrapping, airport runways, pipe, irrigation canals, aqueducts, reservoirs and similar construction. It is also used as fencing, ranging from farm and lawn fence to poultry netting; for flooring, caging, partitioning and grillwork; and as the wire fabric component of many familiar products.



RESISTANCE WELDING
by the mile

An Example of Automation in the Production of Welded Wire Fabric

To supply the nation's appetite for welded wire fabric, Thomson has developed automatic welders which literally produce fabric "by the mile".

The giant fabric welder pictured here makes heavy concrete reinforcement. It turns out over a million square feet a week in widths from eight to sixteen feet in a wide variety of mesh spacing and wire gauges.

It takes the raw material in coils just as it comes from the steel mill and delivers the finished product in rolls or sheets. Rolls are mechanically off-loaded and sheets are automatically sheared into mats of specified lengths.

The Wire Fabric Welder is one of many types of special purpose welders for which Thomson is the recognized source throughout industry. It is also a fine example of automation applied to resistance welding.

A Thomson man will be glad to discuss with you ways to reduce or eliminate work handling in your resistance welding operations. Here is an area in which you can enjoy the advantages and economies of automation *right now*.

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INVENTOR OF RESISTANCE WELDING

THOMSON *Welders*

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Thomson also makes a complete line of standard spot, projection, seam and flash-butt welders. Also, aircraft, brake shoe, shell and other special purpose resistance welders.

New Members

Effective June 1, 1956

MEMBERSHIP CLASSIFICATION

A—Sustaining Member B—Member C—Associate Member

D—Student E—Honorary Member F—Life Member

Total National Membership June 1, 1956	
Sustaining Members	*125*
Members	*5,260*
Associate Members	*5,853*
Students	*179*
Honorary Members	*9*
Life Members	*15*
Total	11,714

AWS Builds Men of Welding

ATLANTA

Smith, Donald A. (B)

BIRMINGHAM

Davidson, Jim (B)

BRIDGEPORT

LaTulip, Joseph G. (B)
Pennella, Angelo F. (B)
Salce, Anthony (B)

BOSTON

Hanson, Howard H. (B)
Kataja, William R. (C)
Spear, Fred W. (B)

CHICAGO

Breyer, Norman N. (B)
Eyestone, John D. (C)
Fenwick, George W. (B)
Hagarty, Thomas J. (C)
Hesterman, Francis C. (C)
Higgins, Christopher G. (C)
Lane, William C. (B)
Mueller, Hans W. (B)
Schneeberger, Robert H. (B)
Thompson, Earl (B)
Tucker, John O. (C)

CINCINNATI

Ruppender, Robert R. (B)
Schuehler, Carl A. (B)
Vonderheide, Val R. (C)

CLEVELAND

Baker, J. N. (C)
Barch, Robert C. (C)
Best, Forest A. (B)
Cope, William E. (C)
Dewald, William A. (B)
Horn, Ronald R. (C)
McGhee, Paul T. (C)
Smith, Elton E. (B)
Sulak, Robert J. (C)
Tate, Fred S. (B)
Zeskey, Harry C. (C)
Zivkovic, Frank A. (B)

COLORADO

Lindberg, E. R. (B)
Scheibel, John (B)
Ulrich, Lee W. (B)
Williams, Bert O. (C)

COLUMBUS

Burkhardt, R. A. (C)
Endsley, Richard A. (C)
Holsclaw, Guy L. (B)
Sellon, William A. (B)

DALLAS

Jolley, Jerry L. (C)

DAYTON

Jones, Harry A., Jr. (C)

DETROIT

Anderson, Walter B. (C)
Chiasson, Bill (B)
Grove, Earl (B)
Gumbert, Charles E. (C)
Janke, Walter E. (B)
Keefer, Ernest G. (C)
Lusher, Hugh G. (B)
Van Pelt, Harold E. (B)

HARTFORD

Griswold, John S. (B)

HOUSTON

Benning, George H. (C)
Blackburn, Henry W. (B)
Clendennen, Ernest (C)
Eldridge, Albert M. (B)
Gramann, Henry T. (B)
Hudson, R. C. (B)
Johnson, Henry M. (B)
McDaniel, Ben A. (B)
Palombo, W. B. (B)
Price, Winfred O. (B)
Simonetti, Chris J. (C)
Spence, Robert M. (B)
Tiller, Lawson (C)
Wright, H. D. (C)

INDIANA

Hayes, John M. (B)
Lee, Paul E., Jr. (C)
Wilson, Harold R. (C)

IOWA-ILLINOIS

Smit, John R. (C)

LONG BEACH

Jones, Ruth H. (D)
Keyte, Lawrence E. (B)
McGregor, W. P. (B)

LONG ISLAND

Boren, Walter L. (C)
Einfurer, Donald C. (C)
Kollock, Alan S. (B)

LOS ANGELES

Avery, W. C. (B)
Bell, Jay C. (C)
Boboricken, Michael (C)
Bourland, Louis H. (C)
Brown, Sherman S. (C)
Cameron, Hugh A. (C)
Driscoll, George (B)
Driscoll, Robin R. (C)
Drummond, Robert L. (C)
Eggen, Ray W. (C)
Eubank, Howard C. (C)
Evans, J. R. (C)
Haryung, John (B)
Herndon, Carroll W. (D)
Kline, Edward T. (C)
Madsen, Harry F. (C)
Putman, Charles C. (C)
Reinhard, Robert R. (B)
Valente, Angelo J. (C)
Van Horik, L. R. (B)
Vetter, Warren H. (C)
Warren, Leland P. (B)
Williams, George G. (C)
Yon, L. L. (B)

LOUISVILLE

Camperman, C. W. (B)
Van Hoy, Robert M. (B)

MADISON

Bertrand, R. E. (B)
Schlichter, Edward J. (B)

MAHONING VALLEY

Taylor, Kirke L. (C)

MARYLAND

Bennett, Floyd K. (C)
Cerey, Roma C. (B)
Fernes, Emil F. (B)
Lingenfelter, Robert (C)
Neuman, Jerome O. (C)
Stack, John N. (C)

MILWAUKEE

Doerr, Francis X. (C)
Hirthe, Walter (C)
Ladwig, A. A. (B)
Manning, Robert (C)

MOHAWK VALLEY

Montero, Richard (C)
Turk, James E. (C)

NEBRASKA

Black, Ralph P., Jr. (C)
McAlister, John H. (B)

NEW JERSEY

Baum, Leonard, Jr. (B)
Castano, Carl (C)
Garbe, H. W. (B)
Lindquist, Robert C. (B)
Rogers, Walter I. (C)
Simms, Forde (B)
Stavenick, Leo V. (B)

NEW ORLEANS

Duplaisir, William E. (C)

NEW YORK

Creed, William V. (B)
Farnstrom, Bengt O. (C)
Feinberg, Joseph (B)
Hembree, E. O. (B)
Lichtenberg, Samuel (B)
Woznick, Walter J. (C)

NIAGARA FRONTIER

Biskup, Joseph (B)
Hock, James J. (B)
Klein, Milton T. (B)
Meredith, James R. (C)
Saxton, William T. (C)
Waters, Roy (B)
Wright, Jerry J. (B)

NORTH CENTRAL OHIO

Gandert, Fred C. (B)

NORTHEAST TENNESSEE

Morris, L. A. (C)

NORTHWEST

Jasper, Kenneth J. (B)
Myers, Bernard P. (C)
Parker, Arthur P. (C)

NORTHWESTERN PENNSYLVANIA

Humphries, George W. (B)
Williams, Bruce R. (B)

OKLAHOMA CITY

Millspaugh, F. C., Jr. (C)

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For applications requiring widely varying welding conditions, normal welding speeds and maximum simplicity.

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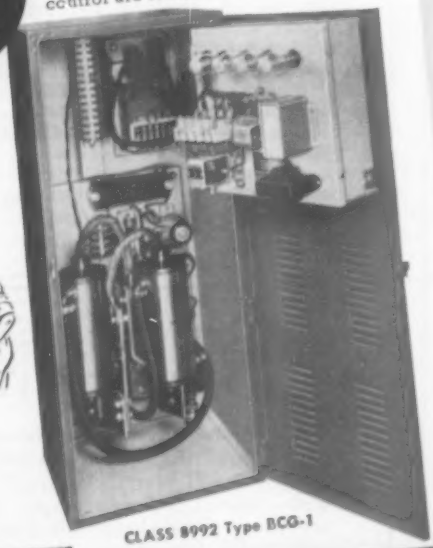
For production line (gun or stationary) welders and other applications where high speed, high currents or dual gun control are factors.



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for Precision Welding
For welding aluminum, other non-ferrous and ferrous metals requiring precision weld times; stepless heat control; slope or taper control.

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PASCAGOULA

Gould, E. A. (C)
Hammett, E. R. (C)

PEORIA

Bliss, Royal M. (B)

PHILADELPHIA

Bilhardt, Lawson, J. (C)
Clark, Robert E. (C)
Fine, Leo M., Sr. (C)
June, Frederick N. (C)
McKearney, T. A. (C)

PITTSBURGH

Morley, Fred J., Jr. (C)
Seidl, Carl E. (B)
William, Robert D. (B)

PUGET SOUND

Hensel, William J. (C)

RICHMOND

Bloxton, S. E. (C)
Femiani, G. J. (B)
Mednick, Maurice L. (B)
Osburn, E. R. (B)
Stinson, Z. T. (C)
Williams, Robert S. (C)

ROCHESTER

Castle, Richard D. (C)
Preece, James (C)

ST. LOUIS

Davis, William E. (C)
Holley, W. M. (C)
Thomas, Rollie H. (B)
Williams, Richard C. (C)

SALT LAKE CITY

Halls, Lynn M. (C)
Higgs, Bryant H. (B)
Hulbert, Fred W. (C)
Strikwerda, K. A. (B)

SAN ANTONIO

Bienek, A. W. (B)
Bienek, John A. (B)
Bonn, R. E. (B)
Burford, C. E. (B)
Burkhart, H. F. (B)
Coston, Wayland K. (B)
Gonzalez, Pablo R. (B)
Hildebrand, Sanford J. (B)
Petty, Clifton (B)
Stecker, J. H. (B)
Wall, J. E. (B)
Wood, William H., Jr. (B)

SAN FRANCISCO

Iodence, Don L. (C)
Rowley, W. C. (B)
White, John F. (B)
Williams, Lawrence J. (B)

SANGAMON VALLEY

Lorton, John L. (C)
Meese, James R. (C)

SANTA CLARA VALLEY

Bales, Clarence G. (B)
Birken, Don H. (C)
Cunha, Frank (B)
Davis, Malcolm M. (C)
Freeman, Donald M. (B)
Goode, Vivian M. (C)
Heitsman, Charles R. (B)
Koll, Otto H. (B)
Ledwick, Donald (B)
Lenhardt, Robert S. (C)
Mallon, George C. (C)
Rose, Frank P. (B)
Sermuks, Henry P. (B)
Tyson, Leo J. (B)
Watkins, Leroy (B)

SHREVEPORT

Davis, Joe L., III (B)
Marwill, Otto H. (B)

SOUTH FLORIDA

Pearson, Walter J. (B)
Pupello, Frank (B)
Williams, T. C. (B)

SUSQUEHANNA VALLEY

LeVan, Herman C. (C)

SYRACUSE

Pray, R. F. (C)

TRI-CITIES

Crabtree, Jerome O. (C)

WASHINGTON, D. C.

Dilg, Leslie E. (B)

WICHITA

Howard, Eugene D. (B)
Wyckoff, H. S. (B)

WORCESTER

Lee, John F. (B)

YORK-CENTRAL PENNSYLVANIA

Dietz, Nevin B. (C)
Horn, John M. (B)
Marley, Walter M. (B)

NOT IN SECTIONS

Carrier, J. P. (B)
Hooper, Arthur L. (B)
Moser, Robert A. (B)
Nakamura, Takashi (B)
Quenneville, Rene (B)
Saruwatari, Minoru (C)
Sebistianowich, C. A. (B)
Winters, M. G. (B)

Members Reclassified During the Month of June

DALLAS

Williams, Charles W. (C to B)
Yentzen, George J. (C to B)

LONG BEACH

Harwart, Edward A. (C to B)

LOS ANGELES

Peck, Robert S. (C to B)

MOHAWK VALLEY

St. Louis, Donald A (C to B)

PHILADELPHIA

Madsen, Stanley W. (C to A)

PORTLAND

Dickerson, Donald R. (C to B)

WANTED! *NOW*

PHYSICAL METALLURGISTS, minimum of 5 years experience with heat-resistant materials.

WELDING ENGINEERS with extensive experience in spot, seam, flash, arc, heliarc, automatic heliarc and consumable electrode welding of aircraft materials. Positions are in metallurgical section of engineering department and involve research, development and consultation with design engineers.

PHYSICAL METALLURGISTS with experience, to coordinate with design groups in the development of aircraft castings with optimum properties.

THIS IS an exceptional opportunity for men with thorough training and experience. Complete technical facilities are available, and working conditions are ideally satisfactory.

ADEQUATE HOUSING in all price ranges, thousands of acres of lakes and parks, a low cost of living (no state sales or income tax), and a mild year around climate make leisure time interesting and relaxing.

TODAY, investigate the challenging opportunities at America's largest and finest aircraft plant. Your professional ability is your only limitation.

Send resume of training and experience to:

EMPLOYMENT SUPERVISOR

CONVAIR
FORT WORTH

A Division of General Dynamics Corporation

WANTED: WELDING ENGINEER

Permanent position with a leader in the design and construction of petroleum and petrochemical plants. It requires a college graduate, preferably with a degree in welding engineering. The man selected will assist the Chief Construction Engineer in the establishment and maintenance of welding quality control on field projects, including investigation or development of new techniques, methods and materials, and he will participate in research and development of welding programs. Excellent salary and many liberal benefits. Please write complete details including salary requirements. All inquiries in confidence.

Box V-336

EDITORIAL—SALES OPPORTUNITY

With national engineering society monthly publication. Resourceful, capable assistant wanted to sell advertising space and to aid with overall editorial and production activities. Field closely allied to metallurgy and metal fabrication. In reply please outline experience, personal history and salary requirements.

Box V-337

ABSTRACTS OF CURRENT PATENTS

prepared by Vern L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington, D. C.

2,745,769—Welding Flux and Method—George Edwin Linnert and Walter R. Satterfield, Baltimore, Md., assignors to Armco Steel Corp., a corporation of Ohio.

This method relates to the preparation for subsequent fusion-welding of an article formed of stainless steel which is high in chromium and manganese content. A viscous solution of lithium carbonate with silicon dioxide is provided in a silicone resin admixture. A thin coating of such materials is spread on a metal surface and then cured thereon to form a hard adherent coating on the metal surface preparatory to welding action to be effected thereon.

2,747,062—Electric Welding and Soldering Gun—Karl Joel Aversten, Lidingo, Sweden.

This special gun is adapted for use with a pin having a fuse wire attached thereto and includes a chuck for engaging such pin. A current carrying member is provided in the gun for engaging the fuse wire. Means electrically insulate the current carrying member from the said chuck.

2,747,063—Portable Electric Spot Welding Tools—Frank Edgar Waring, Macclesfield, England, assignor to Triangle Products Ltd., Hulme, Manchester, England, a British company.

Waring's new tool includes a body part, and an electric stepdown transformer in longitudinal alignment with this body part. A pillar type handgrip is secured to and extends at approximately right angles from the body part, being located substantially at the center of gravity of the tool. A fixed tong and a movable tong are provided carried by the body part.

2,747,064—Apparatus for Making Corrugated Core Structural Sheet Material—Carl A. van Pappelendam, Rivera, Calif., assignor to North American Aviation, Inc.

This patent relates to a new method of making corrugated core sandwich-type weldable metallic structural sheet material. The method includes scoring a flat sheet material along uniformly spaced paths as it is moved along a given path, and folding this material into a corrugated section by bending along the spaced paths. Then sheet material is fed into contact with the corrugated material on both sides thereof and welding current is passed through the assembly of the flat sheet material and adjacent apexes of the corrugated material. This forms a sandwich consisting of the corrugated material as a core and the flat material as facing sheets.

2,747,065—Method for Welding a Joint—Charles Diehl, Ridgefield, N. J., assignor to the M. W. Kellogg Co., Jersey City, N. J., a corporation of Delaware.

Diehl's method is for welding a joint between metal parts not substantially in excess of $^1/_8$ in. in thickness. First, the edges of the metal parts are abutted and fixedly positioned with relation to each other. Heat is applied to adjacent portions of the abutted edges to fuse completely through the thickness of the metal parts and form a molten weld metal pool of approximately constant width. A positive static pressure gas blanket is provided against the bottom face of the joint during fusion and solidification of the weld metal pool, which is held together in position between unfused metal without formation of discreet projections on the bottom face of the unfused metal. The fixed relationship of the metal parts is maintained during fusion and solidification of the weld metal pool.

2,747,077—Portable Welding Lamp—John J. Salm, Vernon, N. Y.

A novel electric light attachment for a pair of welding cables is disclosed in the present patent. The attachment is adapted to be connected in shunt circuit across the welding cables and includes a mounting means in engagement with the workpiece to be welded. The mounting means includes a permanent magnet having an insulating sheath covering a portion of the magnet so that the uncovered portions of the magnet are attached to the workpiece. A ground wire is provided in contact with the magnet and permitting it to be grounded when the magnet is attached to the workpiece.

2,747,152—Torch Spacing Control—William J. Greene, Scotch Plains, N. J., assignor to Air Reduction Co., Inc., a corporation of New York.

This patent is on special means for automatically maintaining substantially constant the distance between two relatively movable members. The control is particularly adapted for regulating the positions of one or more torches.

2,747,155—Welding Generator Control Apparatus—James V. Caputo, Youngstown, Ohio, and Thomas J. Crawford, Berkley, Mich., said Crawford assignor to said Caputo.

This patent relates to motor-generator apparatus wherein a rotatable inertia device is driven by the motor and is arranged to supply rotating power to the generator as a function of a decreasing speed of the rotating part. The generator includes an energizable winding normally supplied from a voltage source, and voltage controlling means are provided. These last means include an auxiliary electric potential generator connected between the voltage source and the energizable winding of the generator and being polarized oppositely to that of the voltage source. Such auxiliary electric potential generator is actuated as a function of the speed of the generator for altering the voltage supplied to the output terminals energized by the generator. Hence, the degree of energization of the energizable winding of the generator can be altered.

2,748,040—Porous Alloyed Welding Fluxes—William M. Conn, Kansas City, Mo.

This patent is on a welding flux based on the alumina-silica system with the addition of glass-forming oxides. The flux is adapted when used in welding to produce a crust and slag having crystalline inclusions therein. The flux primarily comprises silica, titanium dioxide and alumina plus small quantities of calcium oxide and manganese oxide.

2,748,236—Apparatus for Continuous Arc Welding—George G. Landis, South Euclid, and Harold S. Payne, Cleveland Heights, Ohio, assignors to the Lincoln Electric Co., Cleveland, Ohio, a corporation of Ohio.

The patented welding apparatus comprises a combination of a welding head adapted to have welding material fed therethrough toward a workpiece. A base unit is provided for supplying welding material to the welding head, and mast means are mounted on the base unit and extend upwardly and outwardly therefrom. The end of the mast means remote from the base unit is resiliently movable in a vertical and horizontal direction and at least partially supports the weight of the welding head.

2,748,237—Welding Apparatus—Edmour Laporte, Montreal, Quebec, Canada.

Apparatus including a transformer, and a conductor joining the ends of the secondary winding of the transformer is disclosed in the patent. Rectifying means are provided in this conductor. A metal working base is present in the apparatus and a second conductor extends from the first conductor to this base. A welding cement-coated electrode is provided at the

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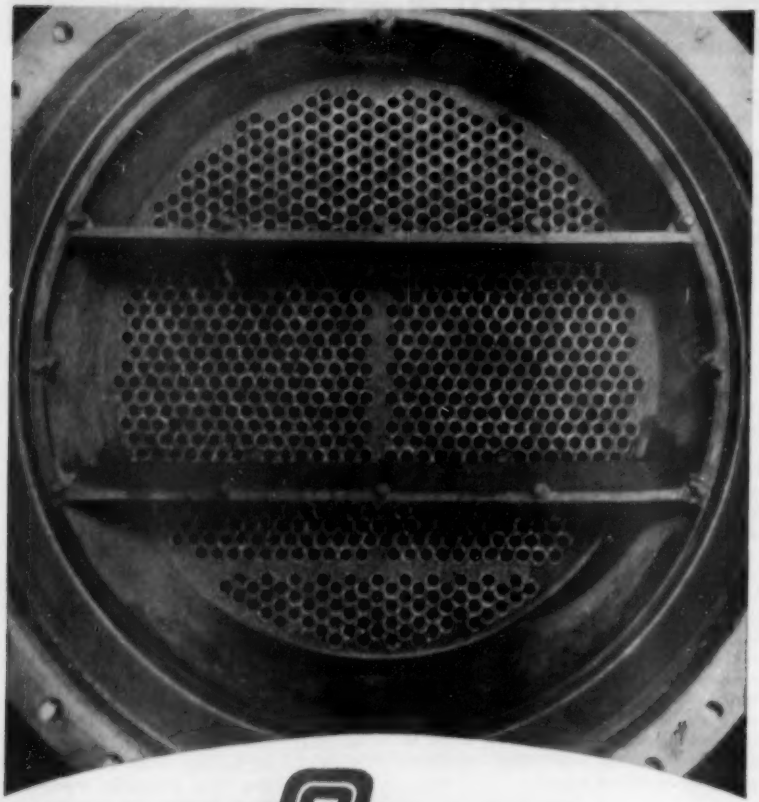

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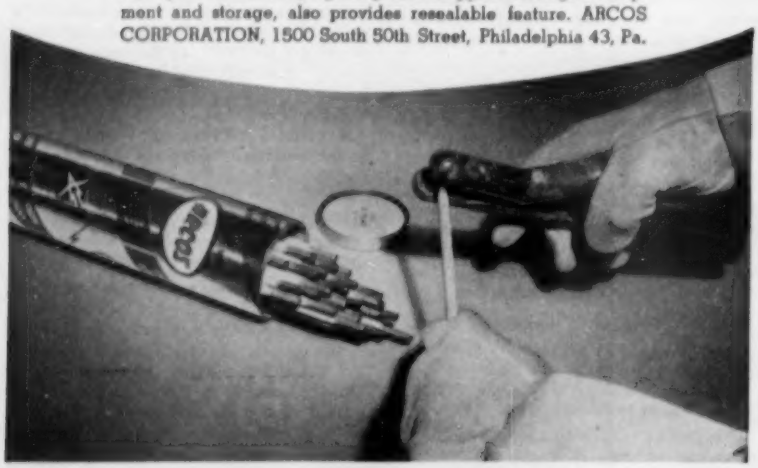

base and a third conductor extends from the mid-point of the secondary winding to this electrode. An accumulator is provided between the second and third conductors whereas an automatic switch is in the second conductor between the accumulator and the base.

2,748,238—Method of Welding Wires Under Tension—Renn Zaphiropoulos, Oakland, Calif., assignor to Chromatic Television Laboratories, Inc., New York, N. Y., a corporation of California.

This patent relates to the welding of a plurality of tensioned wires to a frame which is made up of two sets of oppositely disposed sections so that the wires extend in substantially parallel relationship across a window area defined by the two sets of oppositely disposed frame sections. Initially the tensioned wires are positioned so that they have the relative positions desired after welding and the frame is brought into contact with these wires so that each wire contacts two oppositely disposed frame sections. Each wire is spot welded to each of the two frame sections and is compressed during the welding operation against that particular frame section which is being welded. Hence, the tension in the wire across the window area of the frame is retained regardless of the detensioning effect induced by softening of the wire material as a result of the welding operation.

2,748,343—Electronic Seam Welder—Edward C. Hartwig, Walnut Creek, Calif., and Hubert W. Van Ness, East Aurora, N. Y., assignors to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

The present patent relates to a special combination including three different conductors and means for impressing alternating potentials in opposite phase relationship between the first conductor and second conductor and between the third conductor and the second conductor. Special rectifier and impedance means, as well as other controls, are provided in this circuit control combination.

2,749,380—Resistance Welding Current Indicating Device—William N. Platte and William L. Roberts, McKeesport, Pa., assignors to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

This patent is on a resistance-welding current indicator. The apparatus includes an air toroid adapted to be coupled to the welding circuit, and an integrating network connected to this air toroid. Pairs of discharge devices and biasing means are provided in the control so that the discharge devices will indicate whether the welding current lies between the desired limits.

2,749,417—Portable Electric Spot Welder—Philip R. Griskell, Oak Lawn, Ill.

This patent is on a manually operable portable electric spot welder wherein a stationary transformer has an electrode secured thereto and is mounted in one part of a housing whereas a pivoted transformer has an electrode mounted thereon and is positioned in another part of the housing.

Special lever, spring and grip means are provided for controlling the relative positions of the eletrodes in the welder and the welding action thereof.*

2,749,419—Machine for Welding Contacts onto Switch Parts—Einer W. Larsen, Elmhurst, Ill., assignor to Western Electric Co., Inc., New York, N. Y., a corporation of New York.

This apparatus is for welding contacts onto a plurality of wires of a switch part. The apparatus includes a welding head having a contact movable therewith and means for feeding contacts to the welding head. A holder supports a switch part in a predetermined position to one of the wires in the path of movement provided for the welding head. Other means are operated in timed relation to the contact feeding means for propelling the welding head through a predetermined path to thrust successive contacts carried thereby against the wires aligned therewith to complete welding circuits for percussively welding the contacts onto the wires.

2,749,420—Method of and Apparatus for Attaching Terminals to the Ends of Wires—Albert F. Pityo, Cedar Grove, N. J.

This patent covers a special process for shaping insulated wire to a loop form, stripping insulation from severed portions of the wire at the ends thereof and welding twisted end portions of the wire to tubular terminals provided therefor.

2,749,421—Welding Head Positioner—John Mikulak, Chatham, and Hughe Wotitzky, North Arlington, N. J., assignors to Worthington Corp., Harrison, N. J., a corporation of Delaware.

In this welding head positioner, the transverse member is mounted on a vertical column and has horizontal and vertical movement with relation thereto. A welding stick is movably mounted on this transverse member while the welding head is suspended from the welding stick by special means. Limit switches in the apparatus are actuated by movement of the welding head to energize the motor operated welding stick for raising and lowering action.

2,749,422—Method of Assembling Sheet Metal Elements by Welding—Leon Saives, Billancourt, France, assignor to Regie Nationale des Usines Renault, Billancourt, France.

This patented method is for butt welding two metal sheet parts together. A heat-conductive support having a shallow channel therein is provided and a wire of fusible metal is placed in such channel. The sheet metal parts to be welded are then secured to the support to overlie such fusible wire at the weld zone. Welding heat is applied to the edges of the metal sheets which overlie the fusible wire to heat such edges to fuse them together and to fuse the wire so that by capillary action of the molten metal the wire is united with the edges to form a bead extending along the weld line.

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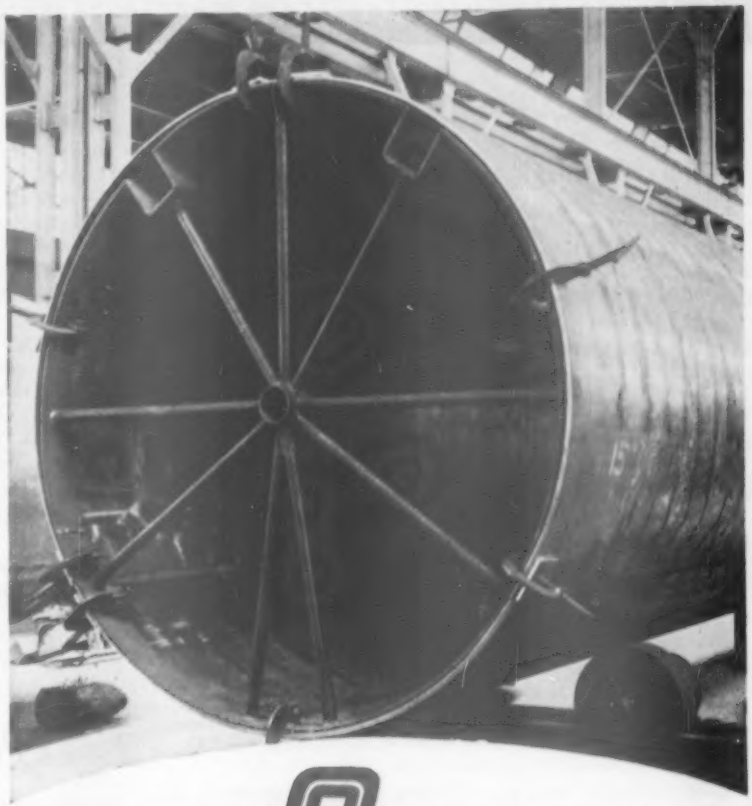

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The advantages of aluminum weld-fabrication are many. But only a quality weld metal can produce them with maximum benefit. Arcos manufacturing controls applied to ALUMAR Spooled Wire are a sure guarantee. Within a critically controlled range you can meet every characteristic with "peace of mind". ARCOS CORPORATION, 1500 South 50th Street, Philadelphia 43, Pa.

Current Welding Literature

For copies of articles, write directly to publications in which they appear

AIRCRAFT ENGINE MANUFACTURE. Control of Welding for Jet Engine Canware, R. Bushell. Welding & Metal Fabrication, vol. 24, no. 3 (Mar. 1956), pp. 76–85.

AIRCRAFT ENGINE MANUFACTURE. Hot Parts for Jet, R. L. Clark. Western Machy. & Steel World, vol. 47, no. 3 (Mar. 1956), pp. 94–97.

AIRCRAFT MANUFACTURE. Spotwelding in Handley Page Herald. Aircraft Production, vol. 18, no. 1 (Jan. 1956), pp. 18–27.

AUTOMOBILE WHEELS. Manufacture of Spot Welded Automobile Wheels, M. H. Grams. Metal Progress, vol. 69, no. 3 (Mar. 1956), pp. 63–67.

BRAZING. Choose Right Brazing Method, P. D. Johnson. Steel, vol. 138, no. 16 (Apr. 16, 1956), pp. 106, 111–113.

BRAZING. Brazing with Silver Alloys Helps Solve Tricky Production Problems, A. W. Swift. Tool Engr., vol. 36, no. 3 (Mar. 1956), pp. 91–95.

BRIDGES, ALUMINUM. Footbridge in Formed Aluminium Sheet, C. Marsh. Light Metals, vol. 19, no. 216 (Mar. 1956), pp. 91–93.

WELDING COSTS. How to Determine Standard Costs in Welding Shops, P. Lockwood. Industry & Welding, vol. 29, no. 2 (Feb. 1956), pp. 109–110, 119.

CRANES. All-Welded Shop Crane, H. E. Boyle. Welding Engr., vol. 41, no. 3 (Mar. 1956), p. 34.

GALVANIZED METAL. Welding of Galvanized Steel, P. W. Jones. Welding & Metal Fabrication, vol. 24, no. 3 (Mar. 1956), pp. 98–101.

HEALTH HAZARDS. Incidence and Prevention of Occupational Hazards in Arc Welding, A. W. Gardner. Welding & Metal Fabrication, vol. 24, no. 3 (Mar. 1956), pp. 104–106.

HYDROELECTRIC POWER PLANTS. Application of Welding in Japanese Hydro-Electric Projects, T. Kamiya and T. Okumura. Brit. Welding J., vol. 3 no. 3 (Mar. 1956), pp. 83–89.

INERT-GAS WELDING. Techniques for Inert Arc Welding Heavy Aluminum Plate, J. A. Cowen. Industry & Welding, vol. 29, no. 3 (Mar. 1956), pp. 54–56, 71.

LIGHT METALS. Arc Welding of Aluminium. Aluminium Development Assn.—Information Bul., no. 19 (Dec. 1955), 92 pp.

LIGHT METALS. Giant Flatbed Truck Trailer. Modern Metals, vol. 12, no. 2 (Mar. 1956), pp. 52, 54.

MAINTENANCE AND REPAIR. Thermit Welding Sugar Mill Machinery, E. E. Cuntz. Welding Engr., vol. 41, no. 3 (Mar. 1956), pp. 56, 59.

METALLIZING. Metal Spraying by Wire Process, H. J. Plaster. Brit. Welding J., vol. 3, no. 3 (Mar. 1956), pp. 73–77.

OIL WELL DRILLING. Oil Rigs Made Stronger by Mig, Submerged-Arc. Welding Engr., vol. 41, no. 2 (Feb. 1956), p. 25.

OXYGEN CUTTING. Flame-Cutting Crews Raze 3rd Ave "El." Welding Engr., vol. 41, no. 3 (Mar. 1956), pp. 32–33.

OXYGEN CUTTING. Portable Flame Cutting in Warehouse. Industry & Welding, vol. 29, no. 3 (Mar. 1956), pp. 50–51.

OXYGEN CUTTING. Propane vs. Acetylene: Comparative Testing Confirms Oxypropane Cutting Value, J. Bland. Welding Engr., vol. 41, no. 2 (Feb. 1956), pp. 22–24.

OXYGEN-CUTTING MACHINES. Use Multiple-Item Templates and Electronic Controls in Flame Cutting. Industry & Welding, vol. 29, no. 2 (Feb. 1956), pp. 65–67, 118.

ROCKETS. Applications of Welding in Rocket Industry, F. H. Stevenson. Western Machy. & Steel World, vol. 47, no. 3 (Mar. 1956), pp. 78–84.

ROLLING MILL PRACTICE. Mechanical Scarfing: Rush Is On, I. H. Such. Steel, vol. 138, no. 14 (Apr. 2, 1956), pp. 104, 106, 108.

SHIPBUILDING. Swedish Ship Welding, I. Wahlstedt. Welding & Metal Fabrication, vol. 24, no. 3 (Mar. 1956), pp. 86–92.

SHIPS. Studies on Mechanism of Origin and Method of Reducing Deformation of Shell Plating in Welded Ships, K. Masubuchi, Y. Ogura, U. Isihara, and J. Hoshino. Int. Shipbldg. Progress, vol. 3, no. 19 (Mar. 1956), pp. 123–133.

SOLDERING. Effect of Fluxes on Soldered Connections, A. Z. Mample. Elec. Mfg., vol. 57, no. 2 (Feb. 1956), pp. 124–128.

STAINLESS STEEL. Build Corrosion Resistance Into Stainless, J. J. Heger. Steel, vol. 138, no. 15 (Apr. 9, 1956), pp. 116–117.

STEEL HARDENING. Big Problems Are Commonplace in Flame-Treating Oil Industry Tools, R. F. Arnoldy. Welding Engr., vol. 41, no. 2 (Feb. 1956), pp. 28–30.

STEEL. Weldability and Mechanical Properties of Series of Mn-Ni-Cr-Mo Steels, C. L. M. Cottrell, B. J. Bradstreet and T. E. M. Jones. Brit. Welding J., vol. 3, no. 3 (Mar. 1956), pp. 90–98, 2 plates.

TESTING. Better Welds Through Improved Inspection, F. Spencer. Welding Engr., vol. 40, no. 12 (Dec. 1955), pp. 40, 42, 44.

TITANIUM AND TITANIUM ALLOYS. Reclaiming Titanium Scrap. Aircraft Production, vol. 17, no. 11 (Nov. 1955), p. 441.

WASHING MACHINES. High-Speed Welder Tests Own Joints, G. Farrington. Iron Age, vol. 177, no. 11 (Mar. 15, 1956), pp. 96–97.

WASHING MACHINES. Production of Domestic Washing Machines. Machy. (Lond.), vol. 88, no. 2251 (Jan. 6, 1956), pp. 4–13; no. 2252 (Jan. 13), pp. 69–72; no. 2256 (Feb. 10), pp. 236–244; no. 2259 (Mar. 2), pp. 299–308.

WATER HEATERS. Automated Welds Lead to Improved Water Heaters, F. T. Tancula. Welding Engr., vol. 41, no. 3 (Mar. 1956), pp. 30–31.

WELDERS. On-the-job Tests for Pipe Welders, J. Fairlie. Welding Engr., vol. 41, no. 2 (Feb. 1956), p. 27.

WELDING COSTS. Production Welding Controls, R. Cleveland. Welding Engr., vol. 41, no. 3 (Mar. 1956), pp. 20–22.

WELDING MACHINES. How Circuit Revisions Improve Automatic Arc Welds, W. F. Williams. Industry & Welding, vol. 29, no. 1 (Jan. 1956), pp. 58–60, 63–66.

PERSONNEL

Gordon Appointed Vice-President

The Board of Directors of the Progressive Welder Sales Co., 3070 E. Outer Drive, Detroit 34, Mich., have announced the appointment of John D. Gordon to the Board, as vice-president and general manager, in charge of all company operations.

John D. Gordon

Mr. Gordon joined the company on June 10, 1956, as Sales Manager. He was recently assistant to the President of Studebaker-Packard Corp. and has an extensive background as management consultant in the automotive field.

Jackson Named Marston Medal Winner

James O. Jackson, a vice-president and a director of the Pittsburgh-Des Moines Steel Co., is the 1956 winner of the Marston Medal at Iowa State College. The medal is awarded annually from a fund established by the late Dean Anson Marston of the Division of Engineering to recognize an outstanding engineering alumnus of the college each year. Award is made at Commencement exercises of the college.

Mr. Jackson is a 1917 graduate of Iowa State College in civil engineering. He has been employed by the Pittsburgh-Des Moines Steel Co. since his graduation. For the past 30 years, he has been in charge of all engineering activities of the company.

Mr. Jackson is a holder of over 30 United States patents covering elevated tanks, wind tunnels and other steel structures. Also, he has contributed articles frequently to the technical press and has presented many papers to technical societies.

He is a member of the American Society of Civil Engineers, the AMERICAN WELDING SOCIETY, the American Society for Testing Materials and the American Petroleum Institute. He is a member and past chairman of the Steel Structures Research Committee of the American Institute of Steel Construction. He has been a member since 1930 of the Welded Tank Committee of the AMERICAN WELDING SOCIETY.

Stout Named Department Head

Lehigh University has named Robert D. Stout head of the Department of Metallurgical Engineering, succeeding Prof. Allison Butts.

Dr. Stout joined the Lehigh engineering faculty in 1939 after serving as metallurgist at the Carpenter Steel Co., Reading. He is noted for his work in the field of welding. In 1943, he was awarded the Lincoln Gold Medal for "Conspicuous advancement of the science of welding." In 1952, he was presented the $2000 award from the American Society for Metals for "outstanding contributions to the teaching of metallurgical engineering." In May 1956, he was given the meritorius service award of the AMERICAN WELDING SOCIETY.

During the summer of 1955, Dr. Stout was one of 17 official American representatives at the International Institute of Welding Conference in Zurich, Switzerland. He was named to serve on the commission to study the behavior of metals subjected to welding.

A graduate of Pennsylvania State University in 1935, he received his master's degree in 1941 and doctor of philosophy degree in 1945—both from Lehigh University. He has authored numerous articles which have appeared in leading technical journals.

He is chairman of the University Research Committee of the Welding Research Council and of the Technical Papers Committee of the AMERICAN WELDING SOCIETY. He is a member of Sigma Xi, research honorary society, and Tau Beta Pi, national engineering society.

Ronay Retires from N.E.E.S.

Monday, June 18th, marked the end of Bela M. Ronay's long, distinguished and highly productive career as superintendent of the Welding Laboratory of the U. S. Naval Engineering Experiment Station at Annapolis, Md.

Bela M. Ronay

Mr. Ronay was born in the Hungarian prairie country in the town of Békéscsaba 65 years ago. He graduated from the Royal Hungarian Technical University with the Degree of Mechanical and Electrical Engineer. In 1915 he joined the Engineering Department of the Thermit Division of the Metal and Thermit Corp. After returning from World War I (having served in the 77th Division of the A.E.F.) he was promoted to head of the Engineering Department, in charge of research for improvement of thermit steel, design of thermit welding methods and equipment and development of test methods to evaluate marine weldments. In 1931 he was appointed to organize a Welding Laboratory at N.E.E.S. The Welding Laboratory became the largest and best equipped in the country devoted exclusively to the development and testing of welding procedures, materials and equipment. Several developments produced under his direction were accepted and are used by industry. The best known are procedure approval testing, welders' qualification tests, low-frequency induction heating, dye penetrant testing, underwater oxy-arc cutting and arc welding, fused-on metallizing and ceramic backing rings. Test methods developed under his direction include fatigue testing of weldments and

Will it fly?

It certainly will! In fact you can find many just like it "flying" through quick-ripening tobacco crops. It's the Case "88," America's newest tobacco harvester. And 100% of the welds are made with A. O. Smith electrodes.

Anniston, Ala. — When this new harvester went into production, J. I. Case Co. production officials knew a major share of costs would be for welding. Therefore, to make sure they were using the best possible procedures, they called on A. O. Smith.

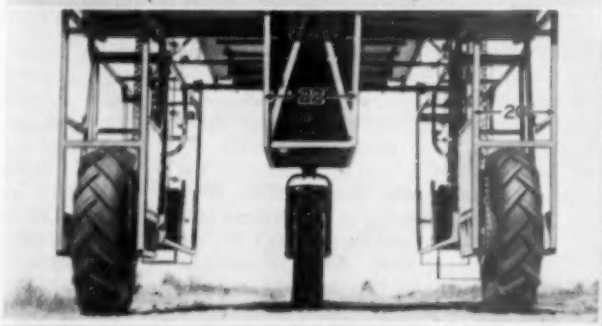
In response, a topflight specialist from A. O. Smith visited their Anniston plant, spent a week surveying their welding procedures.

Result: Welding operations at this plant are running smoothly . . . costs are satisfactory . . . and A. O. Smith SW-14 and SW-65 electrodes are being used for 100% of the welds.

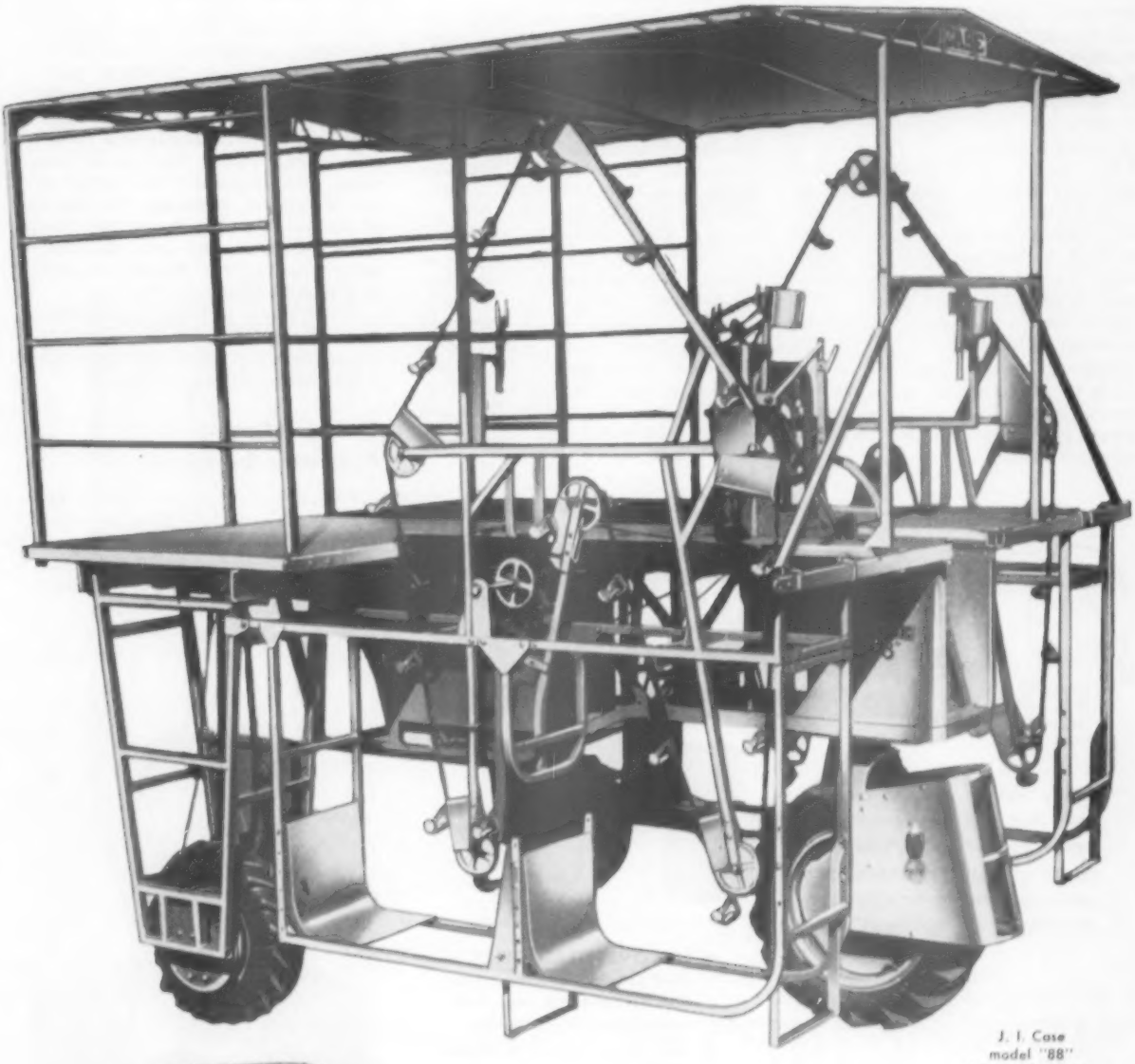
This is one of many examples of A. O. Smith's ability and willingness to help you solve your welding problems — big or small. Why not get in touch with your "man from A. O. Smith" today for all the details.

The man from A. O. Smith
Owen Ford is the A. O. Smith representative who worked with J. I. Case at Anniston. More than a salesman, he's a welding specialist, ready and eager to help you with any of your welding problems.

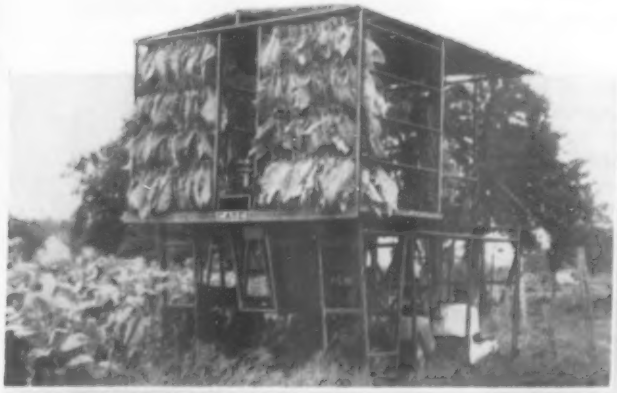
Here's the Case "88" at work. Terrain it must travel is uneven . . . submits frame to severe torsional stresses and strains. Thus welds must be of unusual strength.



This view of the Case tobacco harvester's undercarriage clearly indicates why "small area" welds will have to carry heavy loads without failure.



J. I. Case
model "88"
tobacco harvester



Despite absence of bulky structural member, the Case "88" has a great deal of stamina. At work, it carries a crew consisting of six. It is self-powered with a 25hp Case air-cooled engine.

Through research A.O. Smith *... a better way*

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simulated and synthetic service tests, particularly thermal shock tests, the high-frequency notch-bend test used to determine pre- and postheat treatment in welding low-alloy steels, procedures to determine susceptibility to stress corrosion and means to prevent stress corrosion of weldments.

Mr. Ronay recently received the AMERICAN WELDING SOCIETY'S distinguished Meritorious Award Certificate for his outstanding work in the SOCIETY, of which he has been a member since 1922. He has devoted much time and effort to committee work for the AWS and has been a frequent contributor to the technical literature.

Although he is retiring, Mr. Ronay plans to do consultant work, at his leisure, in the fields of welding technology, pyrometry, instrumentation and induction heating.

Klasson Joins OKI

The appointment of George A. Klasson as manager of the Electric Welding Division has been announced by OKI Welding Supply Co., Cincinnati, Ohio.

Mr. Klasson received his degree in Electrical Engineering from Ohio State University. Since then he has been employed in Engineering, Home Office Sales and Field Work by Westinghouse Electric Corp. For the past few years he has been regional manager of Electric Welding Sales in the southern Ohio area for Westinghouse.

He is a member of the AMERICAN WELDING SOCIETY and the Association of Professional Engineers. In his new position at OKI Welding Supply Co. Mr. Klasson will supervise Sales and Service of Electric Arc Welding Equipment, Supplies and Rods.

Honored by Teachers

At Columbus, Ohio, the National Vocational Agricultural Teachers' Assn. recently honored A. F. Davis, vice-president and secretary of the Lincoln Electric Co., by awarding him the honorary degree of membership in the Association. Paul P. Mechling of Lancaster, Ohio, regional vice-president of the Association, presented the degree at the new Youth Center at the Ohio State Fair Grounds, where the Ohio membership of the Association held its annual conference.

The NVATA members are teachers in rural area high schools throughout the country who teach farm boys the science and art of modern farming.

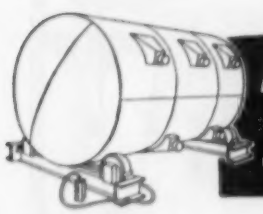
Carl and Oberst Appointed by Burdett

William Loveman, president of the Burdett Oxygen Co., Cleveland, Ohio, announces the appointments of Norman Carl as vice-president in charge of sales and Jack Oberst as general sales manager of all Ohio operations.

Mr. Carl, who began his career with Burdett 20 years ago as a salesman,

Norman Carl

Jack Oberst



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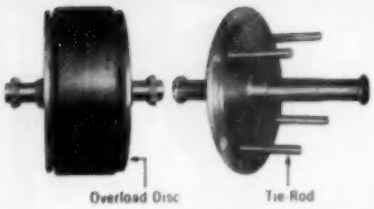
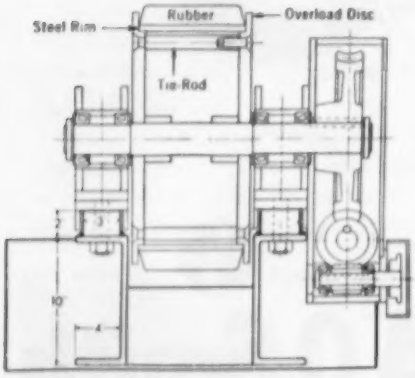
Today there is need of Turning Rolls that will give everlasting continuous service to meet the needs of high production and precision welding techniques — ARONSON fills that need.





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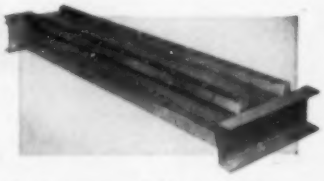
- **PRECISION STEEL WAYS** guarantee perfect alignment of all wheels to hold work exactly true.



Until ARONSON there has not been a thorough study of the requirements and a sound way found to correct certain weaknesses in ordinary turning rolls. You will recognize the problems pointed out and will appreciate the Aronson solution in our new brochure WR-256.

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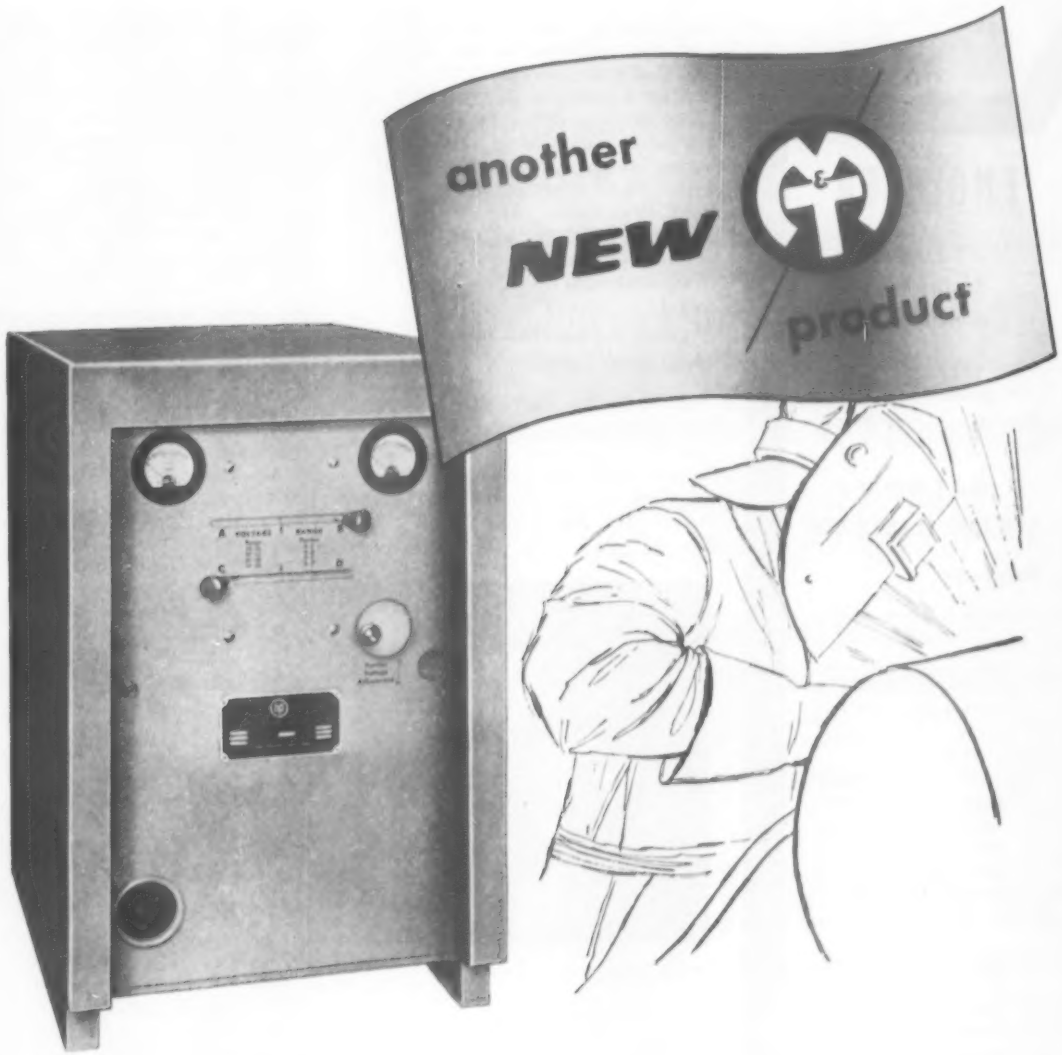

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for semi- and full-automatic welding

Here's another new Metal & Thermit product — the M & T constant voltage rectifier-type DC Welder as developed originally by the Glenn Co. When used in conjunction with a constant speed wire feed for semi- and full-automatic welding, it . . .

SIMPLIFIES OPERATION — for all practical purposes it maintains a constant arc length during entire welding cycle, thereby assuring a uniform deposit.

IMPROVES WELDING — uniform deposits are of high quality, regardless of conditions which normally affect arc length such as poor fit-up, tack welds, etc. — avoids undercutting on horizontal welds.

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CUTS POWER AND INSTALLATION COSTS — high efficiency and power factor permit lower wiring and operating power costs.

M & T Controlled-Arc Power Supply units are saving time and cutting costs on many semi- and full-automatic welding operations. Write for details on how they can help you.

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...A specialist's technical knowledge

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...10–12 years' experience in closely allied fields—physical metallurgy, aircraft engine construction, high temperature alloys

•

...Degree in Metallurgy or Welding Engineers—M.S. preferred but B.S. acceptable, if experience is sufficient.

•

...Age 32–45 (mature, judgment and ability to take responsibility essential)

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was formerly assistant vice-president and sales manager of the company. Mr. Carl is 42 years old.

After a four-year stint in the U. S. Navy, Mr. Oberst was employed by the company as a trainee in 1946. He assumes his new position with extensive experience as a member of the Burdett Sales Department. Mr. Oberst is 37 years old.

Both are members of the AMERICAN WELDING SOCIETY.

Mudge Appointed to New Inco Post

W. A. Mudge has been appointed to the newly created post of Representative on Educational Programs of the International Nickel Company of Canada Ltd., and its United States subsidiary, the International Nickel Co., Inc.

W. A. Mudge

Dr. Mudge will relinquish his duties as Director of the Technical Service Section of the Development and Research Division, which position he has held since 1947. During this time he has also been identified with educational activities carried on by Inco.

Dr. Mudge joined International Nickel in 1920 as a member of the Research Department at the company's Bayonne Works in New Jersey. Subsequently he was successively superintendent of Research, superintendent of the Refinery and Works Metallurgist at Inco's Huntington Works in West Virginia. In 1939, he was transferred to the company's Development and Research Division in New York, first becoming assistant director and then director of the Technical Service Section.

He is a Doctor of Philosophy and Master of Arts graduate of Columbia University, New York, and holds the degree of Bachelor of Science from Union College, Schenectady, N. Y.

In collaboration with Dr. Paul D. Merica, retired president of Inco who is now consultant to the company, Dr. Mudge evolved the first age-hardenable nickel alloy, "K" Monel.

Dr. Mudge is a member of the AMERICAN WELDING SOCIETY, American Society for Metals, American Institute of Mining and Metallurgical Engineers, Society of Automotive Engineers, American Society for Testing Materials, American Society of Naval Engineers, and the Institute of Metals (London, England).

Governor Appoints Seiler to Nuclear Energy Group

Kentucky Governor A. B. Chandler has announced the appointment of John G. Seiler to the nuclear energy group of the Southern Regional Education Board sponsored by the Southern Governors' Conference.

The nuclear energy group is composed of leading industrialists and specialists in medicine, agriculture, manpower and education. It will study peacetime applications of nuclear energy in the South.

Mr. Seiler is president of Tube Turns, Louisville, Ky., a division of the National Cylinder Gas Co.

Weigert Joins Curtiss-Wright

Karl M. Weigert, research metallurgist, formerly with Goldsmith Brothers Smelting and Refining Company, Chicago, Ill., has joined the Research Division of the Curtiss-Wright Corp., Quehanna, Pa.

Dr. Weigert received his degree from the University of Goettingen in Physical Chemistry in 1933. For the last ten years he studied metallurgical aspects of brazing alloys and published several papers on this subject. He is a member of the American Institute of Mining and Metallurgical and Petroleum Engi-

Karl M. Weigert

When one welder gives both AC and DC...

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Certain electrodes work best on... AC

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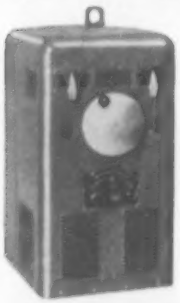

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neers, the American Society for Metals and, as a member of the AMERICAN WELDING SOCIETY, is active in the Committee on Brazing and Soldering.

Burchfield and Spicer Appointed by Inco

William F. Burchfield has been appointed supervisor and Kenneth M. Spicer, assistant supervisor, of Technical Service in the International Nickel Co.'s Development and Research Division, F. L. LaQue, vice-president and manager of the division, announced recently.

Mr. Burchfield has been serving since 1947 as assistant director of Technical Service under Dr. W. A. Mudge, whose appointment as the company's special representative on educational programs was announced recently.

William F. Burchfield

Kenneth M. Spicer

Mr. Burchfield has been with International Nickel in the Development and Research Division since 1929, following four years with a predecessor company, American Mond Nickel Co., prior to which he had attended Lafayette College, Easton, Pa. He is a member of the American Society of Mechanical Engineers, Institute of the Aeronautical Sciences, Society of Automotive Engineers, Society of Naval Architects and Marine Engineers, American Boat and Yacht Council, American Society for Metals and AMERICAN WELDING SOCIETY.

Mr. Spicer joined International Nickel in 1928 as a welding engineer and has devoted most of his attention to technical and practical work on the welding of nickel and nickel-containing alloys as a member of the Technical Service Section. He holds memberships in the AMERICAN WELDING SOCIETY and the Canadian Welding Society.

Production line D-C welder?
Is there any other?

Is there any other welder that compares with the *exclusive* advantages offered by the Westinghouse RA d-c welder? Such outstanding advantages as . . .

An exclusive 100% duty-cycle arc drive to prevent sticking and pop-outs at all settings that gives a hot start for easy starting.

Longer welder life—used indoors or out—because the windings are double-dipped and baked in silicon-fortified Bondite . . . because the exclusive baked-on enamel finish on Bonderized steel assures weatherproofing.

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V-335. Mechanical Engineer for process development and equipment design including automatism of new method for metal removal. An excellent opportunity for the right man to grow with a young, aggressive and rapidly expanding firm. Send brief résumé of education and experience.

V-337. Editorial–Sales Opportunity. With national engineering society monthly publication. Resourceful, capable assistant wanted to sell advertising space and to aid with overall editorial and production activities. Field closely allied to metallurgy and metal fabrication. In reply please outline experience, personal history and salary requirements.

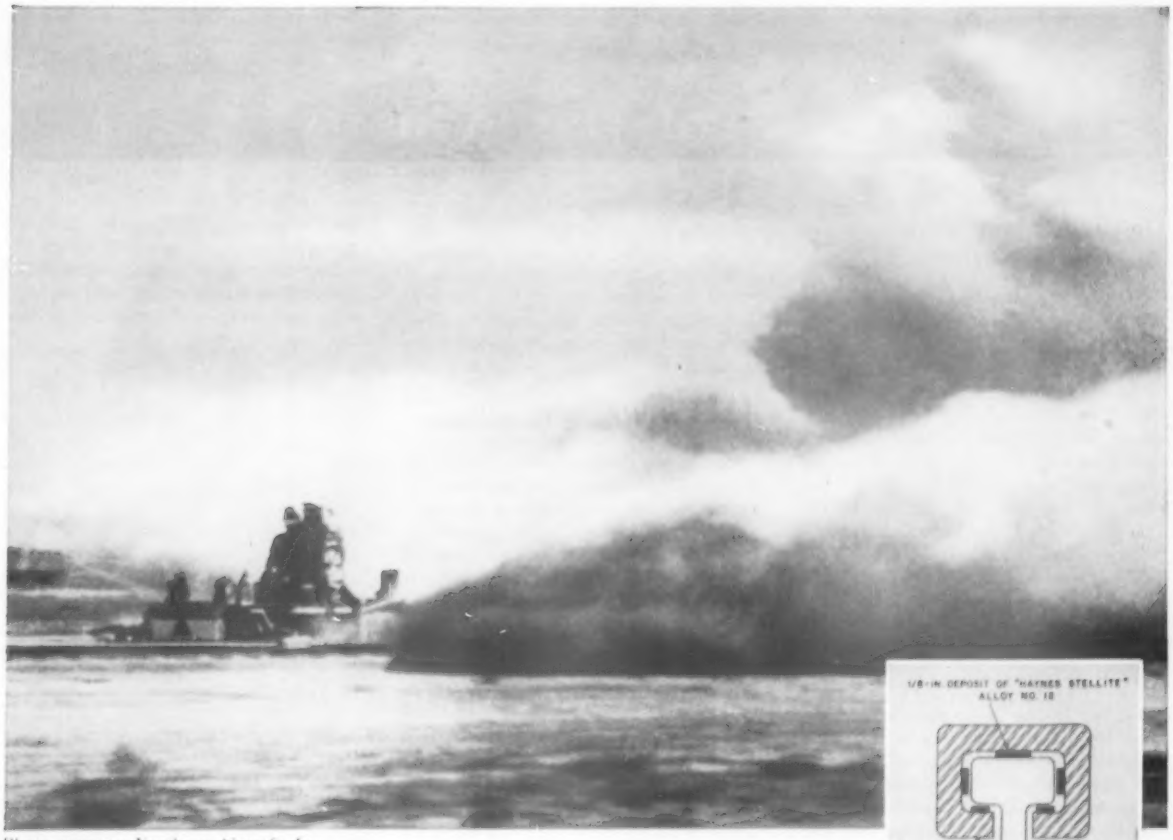

Photo courtesy Northrop Aircraft, Inc.

Rocket Sled Rides at Supersonic Speeds on Hard-Faced Slippers

Four hard-faced slippers bear the entire weight of this rocket-propelled sled as it hurtles down a special railway at more than 900 miles per hour. Hard-facing protects the slippers from abrasion and the tremendous frictional heat generated during each run, and enables them to make 12 trips. Before hard-facing was adopted, the slippers wore rapidly and often had to be replaced after every trip.

As the sketch (above) shows, each slipper is hard-faced at five locations with HAYNES STELLITE alloy No. 12 rod. The cobalt-base alloy is deposited by the metallic-arc method and then finished by machining.

The successful use of HAYNES STELLITE rod on the rocket sled slippers emphasizes several outstanding characteristics of this cobalt-base material. It has exceptional resistance to metal-to-metal wear and frictional heat. It retains its hardness even when exposed to temperatures in the red heat range. In addition, it will withstand the effects of corrosion, erosion, and oxidation, and it has a low coefficient of friction. This combination of properties makes it extremely valuable for protecting such industrial parts as valves, valve seats, bushings, pump shaft sleeves, mandrels, extrusion screws, punches, and dies.

For full information on the complete line of 19 HAYNES hard-facing alloys, designed for every condition of wear, write for the booklet, "HAYNES Alloys Hard-Facing Manual."

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NEWS of The Industry

Oatley and MacKenzie Honored by ASTM

Henry Bigelow Oatley, consultant, and retired vice-president of engineering, The Superheater Co., New York City, and James Tucker MacKenzie, retired technical director, American Cast Iron Pipe Co., Birmingham, Ala., and now associated with the Southern Research Institute, were honored June 19th when they received a certificate of their election to Honorary Membership in the American Society for Testing Materials. The presentations were made during the 59th Annual Meeting of the Society at the Chalfonte-Haddon Hall, Atlantic City, N. J.

A native of Rochester, N. Y., Dr. Oatley received his B.S. degree from the University of Vermont in 1900 and in 1951 the Doctor of Engineering degree, also from the University of Vermont. In 1950 Stevens Institute awarded him the degree, Doctor of Engineering.

In his early professional career, Dr. Oatley worked in the Engineering Department of the American Locomotive Co. from 1900 to 1910 as testing engineer. From 1910 until his retirement in 1950 he was associated with The Superheater Co. He is well known for his achievements in the field of steam generation and has numerous inventions relating to superheaters and other devices.

A native of Brooksville, Fla., Dr. MacKenzie was educated at the University of the South (Sewanee) in Tennessee, receiving his B.S. degree. He received his degree of C.E. and M.A. in 1912 and honorary Doctor of Science in 1930 from the same institution. He was on the research and technical staff of the American Cast Iron Pipe Co. for 44 years until his retirement early this year. He is widely recognized as an authority in the cast iron field, especially the metallurgy of cast iron, centrifugal casting of metals, design of cast-iron pipe and cupola melting.

Dr. MacKenzie has contributed much to ASTM technical work, having been a member of the Society for 38 years, serving twice as Director, 1932–34 and 1944–47. He has been a member of ASTM Committee A-3 on Cast Iron since 1926 and was chairman of the committee from 1944 to 1948. He has written a number of technical papers relating to his field.

Both Dr. Oatley and Dr. MacKenzie are members of several organizations, including the AMERICAN WELDING SOCIETY.

Honorary members are persons of widely recognized eminence in the field of work covered by the Society or who have rendered especially meritorious service to ASTM.

Midwest Welding Conference

Conditions under which it is economical to utilize welding in manufacturing processes, and which welding method is preferred for the particular job, will be stressed at the third annual Midwest Welding Conference to be held in Chicago, Jan. 30 and 31, 1957.

The conference, sponsored by Armour Research Foundation of Illinois Institute of Technology and the Chicago Section of the AMERICAN WELDING SOCIETY, will be held in the Illinois Tech Chemistry Bldg. at 3255 S. Dearborn St.

The two-day program will feature 12 speakers who will present various phases of welding.

Three hundred persons are expected to attend the conference, according to chairman Harry Schwartzbart, supervisor of welding research at Armour Research Foundation.

Resistance Welding Alloy Association is Organized

Manufacturers of resistance welding electrodes and alloys, meeting at the Park-Shelton Hotel, Detroit, Mich., June 11th, formally organized an Association and adopted the name Resistance Welding Alloy Association.

Richard H. Taylor of the Electroloy Co., Inc., Bridgeport, Conn., was elected president, and James A. O'Grady of the Weldaloy Products Co., vice president.

The association management firm, Fernley and Fernley, of Philadelphia, Pa., has been retained to carry on the work of the Association. Marie H. Lawton will serve as secretary-treasurer, and Thomas A. Fernley, Jr., is advisory secretary.

Among the purposes and objectives of the RWAA, as stated in its By-Laws, adopted at the organizational meeting, are:

- To foster and promote the commercial, industrial and business interests of its Members and those in any way related to the Resistance Welding Alloy Industry.
- To promote fair practices surrounding the marketing of the products of the Industry.
- To collect and disseminate statistics and other information.
- To conduct trade promotion activities.

Charter Members of the Resistance Welding Alloy Assn. are: Ampco Metal, Inc., Milwaukee, Wis.; The Electroloy Co., Inc., Bridgeport, Conn.; P. R. Mallory & Co., Inc., Indianapolis, Ind.; Philadelphia Bronze & Brass Corp., Philadelphia, Pa.; S-M-S Corp., Detroit, Mich.; Tipaloy, Inc., Detroit, Mich.; Weldaloy Products Co., Van Dyke, Mich.; Welding Sales & Engineering Co., Detroit, Mich.; and W. W. Alloys, Inc., Detroit, Mich.

Union Carbide Plans to Build in Westchester

Union Carbide and Carbon Corp.'s plans for building on its Westchester property near Tarrytown, N. Y., have been announced by Morse G. Dial, president. The 280-acre site in

COMING EVENTS

A Calendar of Welding Activity

AWS National Meetings

1956 Fall Meeting:
Oct. 8–12, Hotel Cleveland, Cleveland, Ohio
1957 Spring Meeting and Welding Show, Apr. 8–12, Hotel Sheraton, Philadelphia, Pa.

NWSA Zone Meetings

Sept. 24–25, Hotel LaSalle, Chicago, Ill.
Oct. 29–30, Hotel Nicolett, Minneapolis, Minn.
Nov. 1–2, St. Francis Hotel, San Francisco, Calif.

National Metals Exposition:

Oct. 8–12, Thirty-eighth National Metal Exposition and Congress, Cleveland Public Auditorium, Cleveland, Ohio

the towns of Greenburgh and Mount Pleasant was purchased by the corporation in 1952.

Present and future needs of the corporation require the construction of certain buildings in addition to the home office building to be erected on Park Ave. in New York City. These are an office building to house those engaged in work for sales departments of several of the corporation's divisions, a basic research laboratory to conduct general research for the corporation and a service laboratory devoted to research work on customers' problems.

It is planned to start construction of the new buildings early in 1957, and the schedule calls for their completion early in 1959. The buildings are to be two or three stories high, with exterior walls of brick, stainless steel and glass. A central utilities building and a cafeteria for employees also will be constructed.

Morgan Aluminum Welding Rod Co. Moves

Morgan Aluminum Welding Rod Co., manufacturer of aluminum and magnesium welding rods and electrodes, is moving its entire production operation from Cleveland, Ohio, to Mt. Carmel, Pa.

The move into new plant facilities will enable the company to increase its output by at least 100%. Production at the new location began early in July.

Relocation of the plant does not change the address of the company's sales office. It remains at 840 N. Michigan Ave., Chicago 11, Ill.

Arc-Welding Safety Slide Film Available

The Air Reduction Sales Co. has just produced a 20-min, sound slide film, entitled "Always on the Job," covering the basic principles of safety in electric arc welding.

A companion film to Air Reduction's prize winning oxy-acetylene safety slide film, "The Guy Behind Your Back," the new arc-welding safety film also features the light, cartoon approach to this serious topic. Record is 33⅓ rpm speed.

This film is available from any Air Reduction Sales Co. office on a free-loan basis or may be purchased for $15. For more complete information, write to Air Reduction Sales Co., 150 E. 42nd St. New York 17, N. Y.

Valley Supply in Renovated Building

The Valley Supply Co. and the Ottumwa Welding Co. announce that they are occupying part of 40,000 sq ft of the renovated and improved building at 1200 W. Second St. in Ottumwa, Iowa. Russel Pulis and Richard Pumroy, the partners in these two companies, are members of the AMERICAN WELDING SOCIETY.

WELDED OFFICE BUILDING RISING IN NEW YORK CITY

At 530 Fifth Ave. in New York City, a new 26-story building is rising, but the usual construction clatter associated with skyscraper erection in this city is missing. The structural framework is shop and field welded. The 6000-ton structure will contain 26 stories and a penthouse. All major connections on both beams and columns are welded. Field welding totals almost 12 miles in length. Welds are mostly $^{5}/_{16}$-in. fillets made with E-6010 and E-6012 electrodes. Some plate girders, weighing 13 to 15 tons apiece, were welded for the interior of the building, forming the ceiling of a 3-story hall. (Courtesy, Lincoln Electric Co.)

"Airco's complete line of stainless steel electrodes simplifies my buying job"

Airco provides me with a stainless steel electrode with a deposit to match the base metal of the item to be welded. The Airco AC-DC stainless electrode is generally preferred in my shops where only one type of coating is stocked. The AC-DC coated electrodes have the most operator appeal because of the smooth arc action, exceptional bead appearance and very easy slag removal.

Stainless steel electrodes are but one of many types in Airco's complete line that also includes hard-facing, cast iron, mild steel, general and special purpose electrodes. Send for the free Airco Electrode Guide which will help you select the right electrode for your specific job. Request catalog 1318-WJ.

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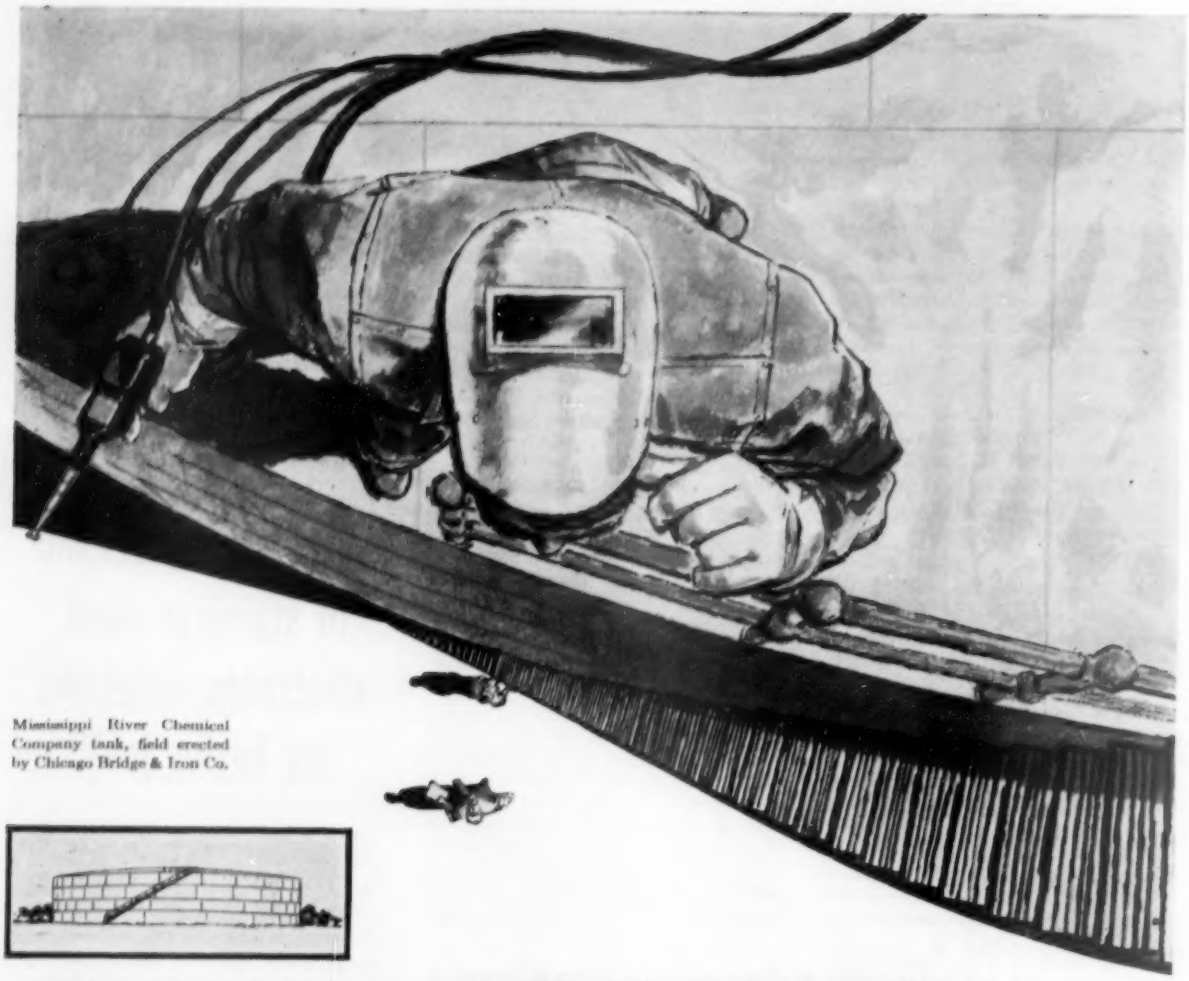

Mississippi River Chemical Company tank, field erected by Chicago Bridge & Iron Co.

World's Biggest All-Aluminum Tank Welded 100% With Alcoa® Alloys

This huge tank holds 2½ million gallons of highly corrosive ammonium nitrate. It's the world's largest aluminum tank—26 feet high and 128 feet across.

To handle the corrosive nitrate, the builder chose aluminum. For the highly stressed parts, Alcoa recommended Alloy 5052 which has a good combination of strength, corrosion resistance and weldability. We also recommended 5052 for the filler metal, a standard welding alloy, desirable here because of its corrosion resistance.

The big job was field erected, using the inert-gas, metal arc-welding process. The bottom course plates are 1⅜ inches and upper courses are progressively thinner, with a ⅜-inch-thick top course. Welds on the finished job were subjected to a standard dye check test. The tank passed this and subsequent water pressure tests with flying colors.

Alcoa made all the aluminum used on this impressive project but we're more proud of the service we were able to render—advising on the alloys, helping get the job started, being Johnny-on-the-spot when any problems came up. We would like to help you weld . . . braze . . . solder in aluminum. Call your Alcoa distributor listed at right. ALUMINUM COMPANY OF AMERICA, 1741-H Alcoa Building, Pittsburgh, Pa.

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ALTERNATE SUNDAY EVENINGS

ALCOA ALUMINUM

FOR IMMEDIATE DELIVERY, call one of the Alcoa distributors listed below. He carries a complete range of alloys and sizes of Alcoa Etched Finished Welding and Brazing Rod, I. G. Consumable Electrode, Brazing Metal, Solder and Flux.

For technical assistance, contact the nearest Alcoa sales office, listed under "Aluminum" in the yellow pages of your phone book.

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CONNECTICUT
Milford
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FLORIDA
Jacksonville
Florida Metals, Inc.
Miami
Florida Metals, Inc.
Tampa
Florida Metals, Inc.

GEORGIA
Atlanta
J. M. Tull Metal & Supply Co., Inc.
Southern Oxygen Co.

IDAHO
Boise
Pacific Metal Co.

ILLINOIS
Chicago
Machinery & Welder Corp.
Moline
Machinery & Welder Corp.

KENTUCKY
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Williams & Co., Inc.

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INTERNATIONAL WELDING NEWS

IIW Commission II—Arc Welding

by John J. Chyle

Commission II—Arc Welding—of the International Institute of Welding is made up of several Subcommissions and so-called Working Groups.

The presently active Subcommissions and their respective assignments are as follows:

1. Subcommission for testing and measurement of weld metal.
2. Subcommission for electrode classification.
3. Subcommission for testing and measurement of arc-welding equipment.
4. Subcommission for deep-penetration welding.

Of the Working Groups organized in Commission II, the following still remain under its general guidance:

1. Working group for the study of hydrogen in weld metal.
2. Working group for crack test on austenitic electrodes.
3. Working group on crack test for welding low-carbon steel and low-alloy high-tensile steels.

The first meeting of the Subcommissions took place in Paris on Jan. 18, 1955, with the Subcommissions on deep-penetrating electrodes, on electrode classification, and on testing and measurement of weld metal participating. A program for the evaluation of sheet-metal electrodes was proposed and discussed.

A second meeting was held in Paris on Mar. 7, 1955. It was devoted to a discussion of the procedure for welding and testing the deep-penetrating electrodes and the sheet-welding electrodes.

This was followed by a third meeting held also in Paris on July 15, 1955, by the Subcommissions on testing and measurement of weld metal. Further modifications and revisions were made for the procedure on testing deep-penetration electrodes and sheet-metal electrodes. Other subjects discussed at this Paris meeting were tests on crack evaluation, tests on stainless steel and electrode weld metal, using several types of evaluation tests such as the solid circular-groove test and segmented circular-groove test.

As part of the activities of Commission II, a great deal of effort is being expended in the classification and testing of deep-penetrating electrodes.

A considerable amount of discussion and several reports have been issued on the testing of sheet-metal electrodes. There is also a great deal of interest in the effects of hydrogen on the properties of weld metal. This subject, however, is still in the early stages of discussion and a large program has been formulated to enlarge this activity.

Some of the investigations being carried out by Commission II are not of current interest to us in the United States principally because we do not use the same type of electrodes as the Europeans do. For instance, we do not make use of the deep-penetrating type of electrodes at the present time, and the sheet-metal type of electrode is not of sufficient importance in our country to create a strong interest on the part of American manufacturers.

The writer, however, feels very definitely that the work which is going on in connection with the investigation of the effects of hydrogen is of considerable importance, and should be followed very closely.

John J. Chyle is the official American delegate on Commission II of the International Institute of Welding.

This report was prepared prior to the July 1956 meeting of the IIW in Madrid.

Lincoln Electric Announces Expansion

The Lincoln Electric Co. of Cleveland, Ohio, has announced an 8-million dollar expansion to its plant capacity for manufacturing arc-welding machines and electrodes. Work is under way to complete 2 million dollars of this expansion by the end of the year. Engineering on the remainder of the work is starting. The entire project is planned for completion within the next three years.

The expansion will provide 60% more manufacturing capacity in the company's five-year-old, 20-acre Cleveland plant. Extensions will be made to the building for new facilities and new equipment will be installed in existing production areas.

The company is also building new plants in France and Australia to replace the present plants in those countries and is also adding to its Canadian plant.

New G.E. Welding Distributor

Sanders and Stewart, Inc., of Jackson, Mich., has been named a General Electric welding equipment distributor, according to an announcement by C. I. MacGuffie, marketing manager of the company's Welding Department.

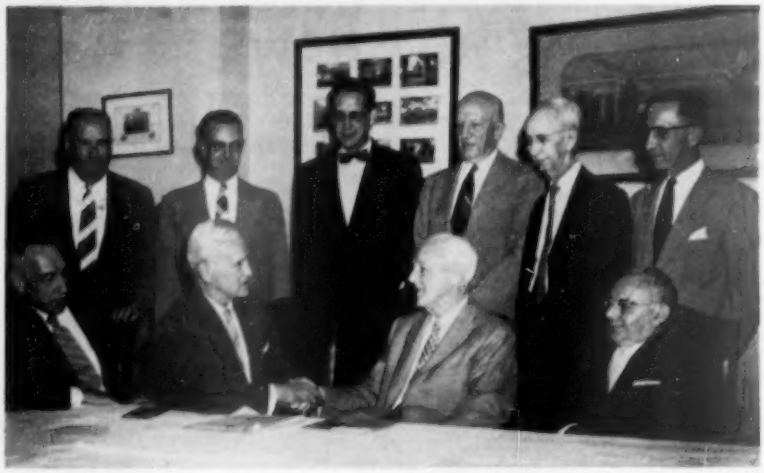
The new distributor, located at 608 E. Pearl St., Jackson, Mich., will handle the complete line of General Electric welding equipment. Territory covered by Jackson and Stewart will include Branch, Calhoun, Hillsdale, Jackson and Lenewee counties.

District Engineers Appointed

KSM Products, Inc., Stud Welding Division, Merchantville, N. J., announces the appointment of M. L. Sundeen as District Engineer for the KSM District Office in Detroit. He will supervise and service Stud Welding Accounts in the states of Michigan, Ohio and Indiana.

H. J. Redding, was appointed to the KSM District Office in Chicago. He will supervise and service Stud Welding Accounts in Northern Illinois, Wisconsin, Minnesota and Northern Michigan.

FERGUSON FETED UPON HIS RETIREMENT



William Ferguson (AWS), seated second from right, retiring after 10 years as chairman of the Uniform Boiler and Pressure Vessel Laws Society, receives congratulations from Herbert W. Heinrich, recently elected chairman, as members of the Society's council look on. Seated (*left to right*) are: Henry E. Aldrich (AWS), American Boiler Manufacturing Assn.; Heinrich, Ferguson and Marcus Abramson, Association of Casualty and Surety Companies. Standing (*left to right*) are: Frank X. Gilg, Babcock and Wilcox Co.; E. M. Kloeblen, Linde Air Products Co.; John L. Menson (AWS), Combustion Engineering, Inc.; R. A. Locke, Steel Boiler Institute, Inc.; Paul Diserens, Compressed Air and Gas Equipment Mfrs.; H. F. Reinhard (AWS), Linde Air Products Co.

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MINIMIZES WEAR CAUSED BY IMPACT AND ABRASION
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11%-13½% MANGANESE-NICKEL STEEL
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are available in 23 sizes to fit any
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• Write for "how-to-do-it" details. It shows you how to save time and money.
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NEAREST DISTRIBUTOR UPON REQUEST

Lincoln Announces "Weldealer" of the Year

Al Patnik, dealer sales manager for the Lincoln Electric Co. Cleveland, Ohio, has awarded the California Welding Supply Co. of Stockton, Calif., top honors from among Lincoln's 1200 dealers throughout the country. Patnik gave the California company the "1955 Weldealer of the Year" Award. A plaque for the award was presented to "Doc" Raymond, president, and Ira Felkins, vice-president, by C. L. Stocker, Lincoln's district engineer in the San Francisco area.

Ira Felkins (*center*) and "Doc" Raymond (*right*) of California Welding Supply Co., holding "Weldealer" plaque presented to them by C. L. Stoker of the Lincoln Electric Co.

It took me just
10 seconds to decide
"This is for me!"

Over a million feet of TWECO-LITE Aluminum Welding Cable is now in use in shipyards, railroad shops, steel fabricators, maintenance shops and job shops. Most of this tremendous customer acceptance came after shop testing a trial length of this new, lightweight cable. Used with the new AL-300 Forged Aluminum TWECOTONG Electrode Holder it makes a lightweight team that reduces Weldor Fatigue, provides maximum flexibility and reduces production costs. Try a length of TWECO-LITE in your own welding shop with an AL-300 TWECOTONG Holder. You and your weldors will be glad you did.

AL-300 TWECOTONG

FORGED ALUMINUM ELECTRODE HOLDER

YOU CAN INSTALL THE AL-300 TO ANY CABLE IN ONE MINUTE WITH THE NEW EASY TO ATTACH CABLE CONNECTION

WEIGHS ONLY HALF AS MUCH AS YOUR HELMET • 13½ OUNCES

DOUBLE BENEFIT TWINS MORE BEAD . . . LESS FATIGUE

TWECO-LITE ALUMINUM WELDING CABLE

HALF THE WEIGHT OF COPPER . . . AT LESS COST

PACKAGED 100 ft. 50 ft.

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SEE YOUR WELDING SUPPLY DISTRIBUTOR

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PRODUCTS, INC.

MANUFACTURERS

WICHITA 1, KANSAS • P.O. BOX 666

NEW PRODUCTS

Lightweight Torches

A new lightweight welding torch, with a welding range from 32 gage to $^3/_8$ in. thick, has been introduced by Linde Air Products Co., a division of Union Carbide and Carbon Corp. Designated the Purox W-200, this light-range blowpipe is described as being specifically designed for production welding in aircraft and small parts manufacture, and for repair and maintenance operations in auto-body shops, sheet-metal shops and garages.

Nine quick-change heads for the W-200 seal gas tight to the blowpipe handle by means of "O" rings and can be turned on the blowpipe handle while welding.

This blowpipe can be adapted for cutting iron and steel from $^1/_{16}$-in. sheet up to plate 2 in. thick with the Purox CW-200 cutting attachment.

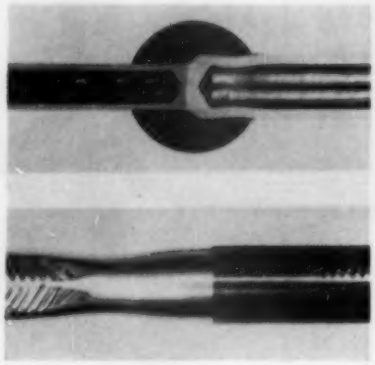
Cutting nozzles for this attachment are available in three sizes for general-purpose cutting.

More information on the Purox W-200 Blowpipe and CW-200 Cutting Attachment may be obtained by writing Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y. Ask for Form 50181.

Cable Connector

A new patented connector for joining aluminum to copper electrical conductor in severe natural environments has been developed by Kaiser Aluminum & Chemical Corp. According to the manufacturer, it has been found to perform satisfactorily in areas where other available connectors have failed in a relatively short time.

Designated the ALCUnector, in one form it consists of a deep aluminum cup and one of copper butt welded together at the closed ends and hermetically sealed in a rubber ball and cement system.



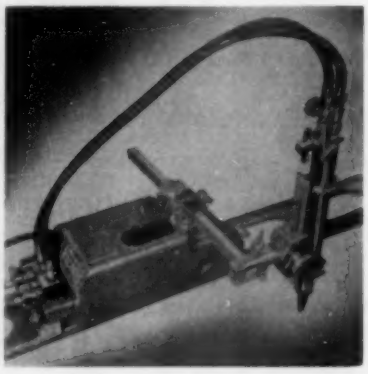
The ALCUnector is said to eliminate the two principal problems experienced in the past in joining the two dissimilar metals—galvanic corrosion and thermo-elastic ratcheting—and is designed for use particularly in marine and other highly corrosive atmospheres where other connectors have failed.

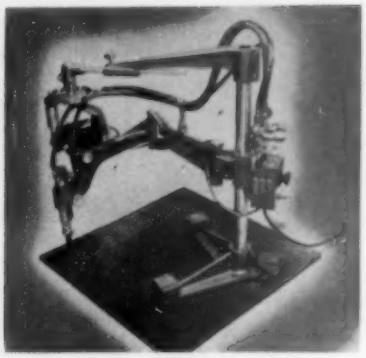
For complete details, write to Kaiser Aluminum & Chemical Corp., Kaiser Bldg., 1924 Broadway, Oakland 12, Calif.

Oxygen-Cutting Machines

Two oxygen-cutting machines have recently been introduced by the Victor Equipment Co., 840-54 Folsom St., San Francisco 7, Calif.

The first of these is Model DC-2000 "Duplicutter" Portable Shape Cutting Machine. According to the manufacturer, the flexibility and simplicity of operation allows one man to handle the production output of two or three "Duplicutters." Lightweight and portable, it can be quickly and easily carried to the work location, thereby reducing time and cost of material handling. Templates are easily and quickly changed to facilitate short production runs.





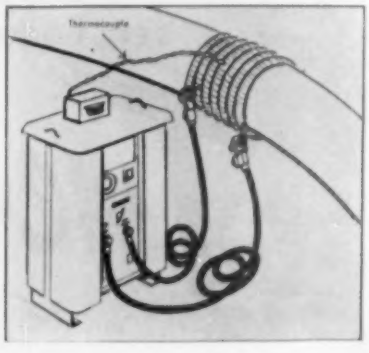
The second unit is the Universal Portable Flame-Cutting Machine, Model VU-120. This new unit is said to be designed for maximum speeds and applications in cutting straight lines, square and bevel kerfs and circles. Also, it has provisions so that it can be adapted for various automatic electric welding applications, using either the submerged-arc or inert-arc processes.

For complete details, write directly to the Victor Equipment Co. at the above address, asking for a copy of Bulletin 353.

Resistance Heating Element

A new electrical resistance heating element has been developed by the Arcos Corp., Philadelphia, which makes preheating or stress relieving pipe welds easier, less expensive and more precise. The new method also requires less time and labor, according to the manufacturer.

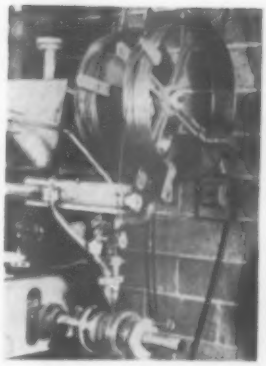
Basic feature of the technique or ele-



ment, known as Heat-O-Coil, is a length of small diameter resistance wire. The full length of the wire, except for several inches on each end, is strung with ceramic ball and socket beads.

Each end of the coil is formed into a small ring. After wrapping the coil around the welded section of the pipe for stress relieving, the two ends are connected to the terminals on a welding machine.

Complete details are available by writing to Arcos Corp., 1500 S. 50th St., Philadelphia 43, Pa.



Welding Regulators

Air Reduction has announced the availability of a new line of low-priced, inverse-type oxygen and acetylene pressure regulators. Known as the Airco Series 8000 Regulators, they are reportedly designed to meet the needs of the smaller metal fabrication shops where initial costs are a factor.

The regulator body is a machined brass forging and the spring case is a zinc die casting protected by a clear iridite finish for increased corrosion resistance.

For maximum readability, the brass

pressure gages have crowned, clear crystals.

For more information about Air Reduction's new 8000 Series Regulators, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Automatic Hard-Surfacing Wires

The McKay Co. announces the availability of their new improved automatic and semiautomatic hard-surfacing wires. Called by the brand name "Tube-Alloy," the new copper-coated, alloy-filled wire is described as producing uniform welds comparable in performance to that of solid wire.

A McKay bulletin, describing the new "Tube-Alloy," reports closer control of chemistry and hardness with trouble-free feed. The bulletin outlines the many applications of the new tubular wires and their advantages. It charts six grades of wire, together with a typical analysis of each and the end hardness obtainable.

Copies of the Tube-Alloy bulletin may be obtained by writing to the McKay Co., 303 McKay Bldg., Pittsburgh 22, Pa.

Paste-Type Brazing Flux

A new paste-type flux for high-temperature brazing of stainless and other high-alloy steels is now available from Stainless Processing Division of Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

Called Nicrobraz Flux, the new material clean and promote wetting of the surfaces to be joined and helps dissolve oxides during the brazing action, according to the manufacturer. The oxidation protection accomplishes four important brazing objectives: (1) it contributes to production of better joints on stainless steels and particularly when brazing difficult alloys such as Inconel X and other special alloys containing elements that place them

AT THE FRONTIERS OF PROGRESS YOU'LL FIND

AN AIR REDUCTION PRODUCT

FOR WELDING AND CUTTING...

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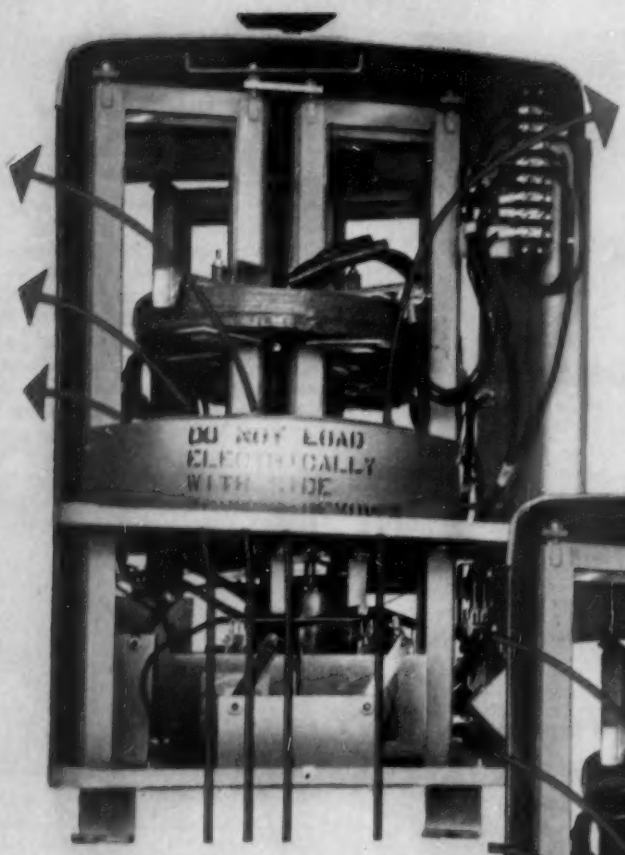
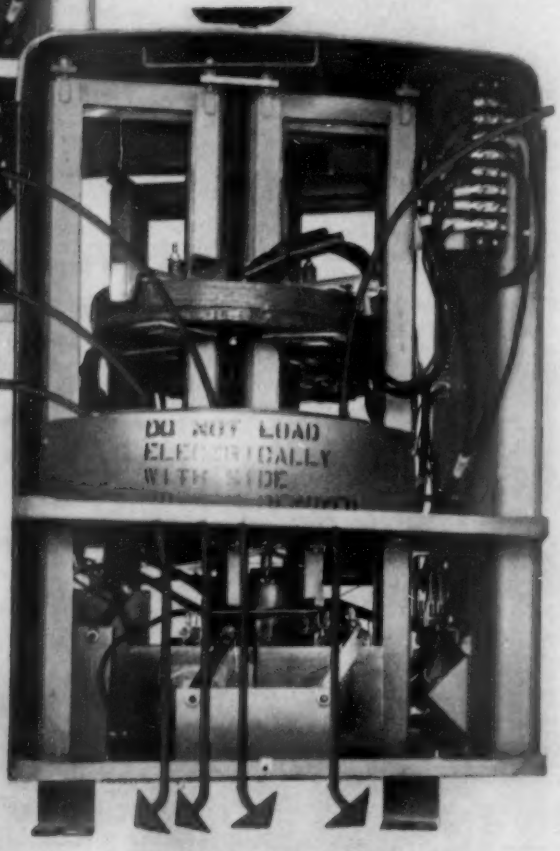
Another



SWITCH DOWN

With switch in normal down position fan draws cool air up through welder.



SWITCH UP

With switch up air is blown down through rectifier stacks to dislodge dust.

FOR ALL YOUR WELDING NEEDS

General Electric offers all three types of heavy-duty welders—AC Transformer, DC Rectifier, Motor-generator—plus a complete line of equipment, accessories, and electrodes.

AC Transformer

Motor-generator

Engine Drive

General Electric Exclusive

Reversible Fan Dusts Off Rectifier in Seconds; Gives General Electric Rectifier Welders as Much as 50% Longer Life

Available only with General Electric rectifier welders, the 14-in. combination cleaning-cooling fan gives you as much as 50% longer welder life!

Here's why! This double-duty fan automatically cools the welder, continually drawing cool air from floor level, up through the rectifier stacks, and over the coils. The possibility of recirculating warm air is thus eliminated.

At the flick of the convenient switch the fan reverses, blowing accumulated dust off the rectifier stacks. This cleaning action helps free the stacks of fibrous dust which frequently blankets the leading edges of rectifier plates, blocking the air flow between the plates and causing burnouts.

Other exclusive features of this new line of General Electric rectifier welders include:

(1) FULL-TIME ARC-FORCE CONTROL which helps eliminate electrode sticking. This feature, exclusive with General Electric, permits the use of shorter arcs, because short-circuiting metal droplets which ordinarily would freeze to the electrode are blasted away.

(2) SILICONE INSULATION on both transformer coils helps protect the welder from damage due to overheating, fumes, and moisture.

(3) EASILY REMOVABLE SIDE COVERS which come off with removal of just three screws. This simplifies routine maintenance; no need to remove primary leads or handles —no need to use cranes or hoists.

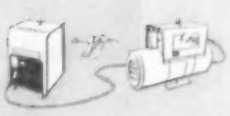
These and other G-E engineered extras (see comparison chart below) are available only with G-E rectifier welders. Contact your local General Electric Welding Distributor (he's listed in the yellow pages of your phone book) or write for bulletin GEA-6242, Section 711-5, General Electric Company, Schenectady 5, New York.

	Full-time arc-force control	Combination cleaning-cooling fan	Moving-coil design	Silicone insulation	Aluminum-wound coils	Removable side covers	Reversing-polarity switch	Large, logarithmic current scale
General Electric	✓	✓	✓	✓	✓	✓	✓	✓
Manufacturer A					✓			
Manufacturer B							✓	
Manufacturer C			✓					✓

Progress Is Our Most Important Product

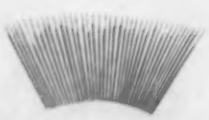
GENERAL ELECTRIC

DC Rectifier



Semi-Automatic

Automatic



Electrodes

Accessories

high on the electromotive series; (2) it permits high-temperature brazing with an oxyacetylene torch and without special atmospheres; (3) it permits use of less expensive atmospheres when furnace brazing stainless steels and high-chromium alloys; and (4) it permits the brazing of titanium or aluminum bearing stainless alloys in hydrogen atmospheres.

For further details, write directly to Wall Colmonoy Corp. at the previously given address.

Engine-Driven Welder

A new engine-driven welder, with battery start and direct coupling between engine and generator, has been announced by the General Electric Co.'s Welding Department.

Available in 300- and 400-amp models, the new welder includes reversing switch, battery start and side panels as standard equipment. Built to withstand heavy-duty service, the new welder is constructed of extra-heavy steel and has no projecting generator or controls that could be damaged in on-the-job operation.

Both 2- and 4-wheel trailers are available to meet varying requirements.

The two-wheel trailer features a small, retractable 12-in. diam wheel on towbar to simplify handling.

Gasoline driven models are equipped with Hercules JX4 engines, rated 54 hp at 2150 rpm.

The 300-amp unit, designated 30AG, has a welding range of 60 to 375 amp and electrode capacity of $^{3}/_{32}$ to $^{5}/_{16}$. The 40AG, rated 400 amp, has an operating range of 80 to 500 amp and electrode capacity of $^{1}/_{8}$ to $^{3}/_{8}$.

For complete details, write to General Electric Co., Welding Department, Schenectady 5, N. Y.

Dispenser for Welding Wire

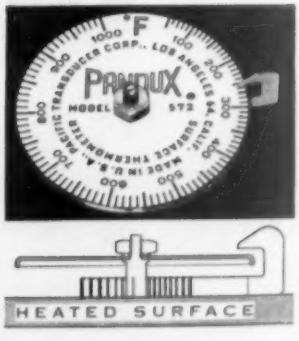
"Payoffpaks," described as a revolutionary and different method for the handling and dispensing of welding wires, are now being offered by the Page Steel and Wire Division, American Chain & Cable Co., Inc., Monessen, Pa. According to the manufacturer, "Payoffpaks" are lightweight and durable and protect wire against coil distortion or wire corrosion. They are compact, easily opened and resealed, roll and stack easily, and take little floor space.

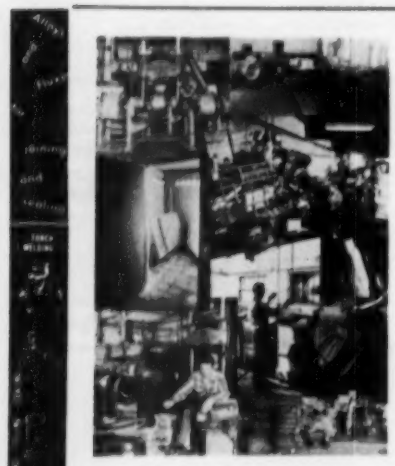
The dispenser offers the advantage of continuous welding up to 500 lb of deposited weld metal with no "downtime" or replacing of small coils or reels. The wire feeds steadily and smoothly from the "Payoffpak" giving uniformity of feed, which is a requisite for perfect welding in either submerged-arc or inert-gas automatic welding.

For complete details, write to American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.

Surface Thermometer

Pacific Transducer Corp., 11836 W Pico Blvd., Los Angeles 64, Calif., announces a new Spot Check Surface Thermometer. This is reported to be a new type of thermometer, made entirely of stainless steel, with a range of from 50 to 1000° F. According to the manufacturer, it is easy to read—compact and very fast-operating. Merely lay the instrument on the surface to be checked—within 60 sec the thermometer will reach stability, and exact





Typical views of ALL-STATE production facilities at White Plains plant

ALLOYS All-State FLUXES

EXPANDING Again!

New construction now nearing completion will add more than a third to ALL-STATE capacity to serve the "metal joinery" needs of industry with alloys and fluxes for welding, brazing, soldering, tinning and cutting.

Ask for "Buyers Guide"

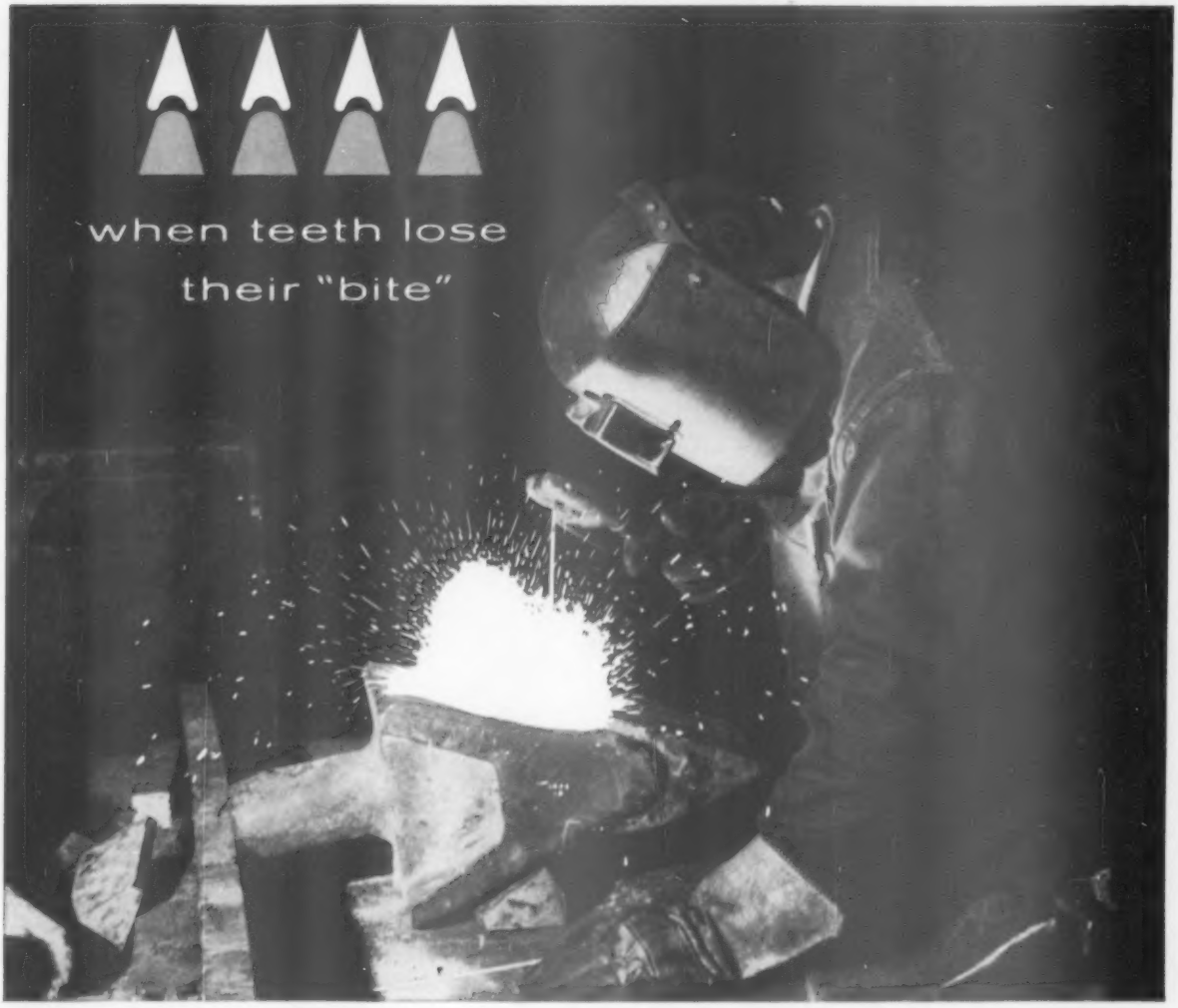
WALL CHART TO HELP YOU SELECT BEST FOR JOB FROM 86 ALL-STATE PRODUCTS

Put one up in your supply room . . . another on your shop wall . . . to help guide selection of the right Alloy and Flux for the job at hand.

19" x 22" Coated Paper

Ask your A-S Distributor for Copies. He'll also give you same data in a folder to fit 3-ring binder.

ALL-STATE WELDING ALLOYS CO., INC., WHITE PLAINS, N. Y.



It's a **15-MINUTE REBUILDING JOB** with Amsco® Cast-to-Shape Repointers

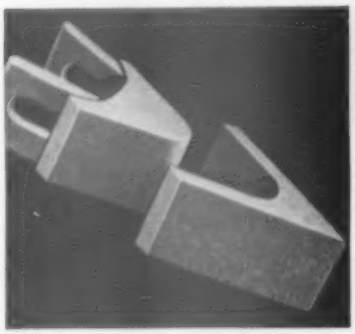
Easy to weld on . . . add strength and service life to entire tooth

Where dipper-tooth wear is moderate, and where digging conditions are not too severe, Amsco Cast-to-Shape Repointers provide a cost-saving answer to tooth replacement.

An average-size tooth can be completely rebuilt in about 15 minutes. The repointer overlaps the tooth top and bottom and is easily welded in place, using only a few electrodes.

Cast of Amsco Manganese Steel, with "ears" that protect the flat sides of the tooth, these repointers add strength and service life to the entire tooth. Available as individual repointer units, or in bar lengths.

For heavy digging, use Amsco "Wear-Sharp" Repointers or Repointer Bars. Order Amsco Repointers from your nearby Amsco Distributor.



AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

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Distributed in Canada by Canadian Liquid Air Co., Ltd.

WATER MIZER

Model ET101
Patented TM Reg.

Water is Scarce! Why Waste It?

WATER MIZER saves water—and money, too. Here is a typical example how **WATER MIZER** controls cooling water on resistance welders and saves up to 80% on consumption. Data below is from an actual production job test in a well-known factory.

BEFORE INSTALLATION

8 hour work day
8 hours of water flow
2960 gallons used

AFTER INSTALLATION

8 hour work day
1⅛ hours of water flow
493 gallons used

WATER MIZER pays its way in a short time. Satisfied users report very little servicing necessary. Ask for data on units for resistance welders, for induction heating, for hydraulic systems.

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Territories Open for Distributors

Gov't Surplus
ELECTRIC WELDERS

(Electric Motor Driven)

Guaranteed Like-New Condition.

300 amp. 220-440 volt. 3 phase. Some P & H, Westinghouse, G. E.

$295.00 EACH

Will sell on open account to accredited companies.

ORDER YOURS TODAY!

call, wire or write

FULTON AUTO EXCHANGE
2235 Stewart Ave., S. W., Atlanta, Ga.
Telephone PO. 7-8606

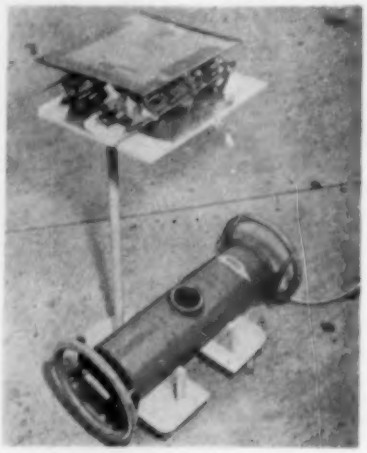
temperatures can be easily read. It can be used to determine the temperatures on hard-surfacing welds, for preheating of metals to be welded, for furnace welding and for other applications up to 1000° F.

The spot check surface thermometer comes calibrated to within ±2%, and can be reset by the user, if necessary, at any time. The diameter is $1^3/_4$ in. overall, and the weight is $^1/_2$ oz. The unit is known as Model 573.

For complete details, write to Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.

Portable X-ray Unit

Checking welds on rocker box covers by portable X-ray is a new method adopted by Pan American World Airways. Welds on damaged rocker



box covers caused by chafing receive thorough X-ray examination for cracks or oil leaks before reinstallation on planes. Andrex portable equipment is used for checking welds and in examination of radiators, bank manifold harnesses, cylinders and fuselage structures. Units available from Holger-Andreasen, Inc., 703 Market St., San Francisco, Calif.

Welder and Positioner

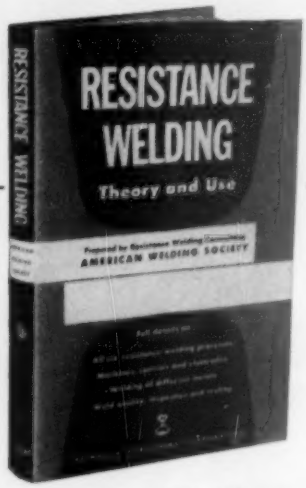
The new Rexarc RP-43 roll and idler welder and positioner is an extremely versatile "packaged unit," engineered for automatic welding on circular shapes such as rolls, idlers, sheaves, crusher weldments, according to its manufacturers, the Sight Feed Generator Co. of West Alexandria, Ohio.

Quick and easy changeover engineering supposedly makes set-up time a minimum. Whether hard-surfacing tractor rolls, building up flanges or other circular weldments, or even longitudinal weldments, the RP-43 will do them automatically. Many distinctive features are offered.

Full details on all six processes!

RESISTANCE WELDING
Theory and Use

Prepared by
Resistance Welding Committee
AMERICAN WELDING SOCIETY



1956, 164 pages
AWS member price—$3.60
Non-member price—$4.50

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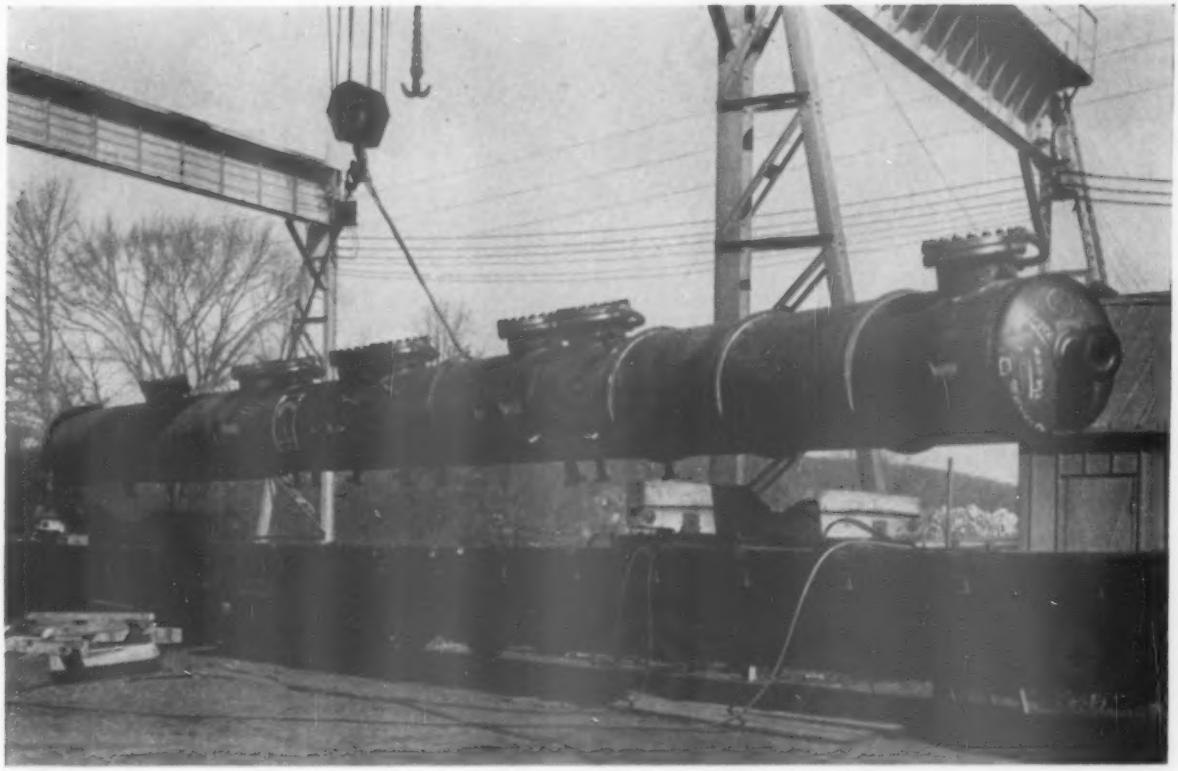

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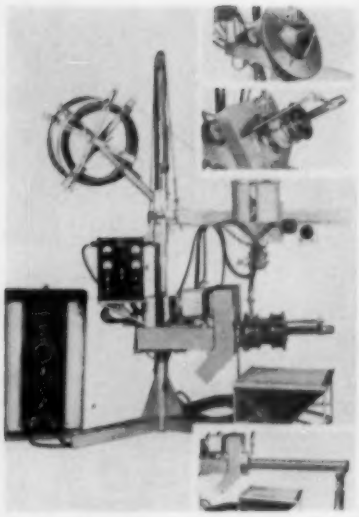
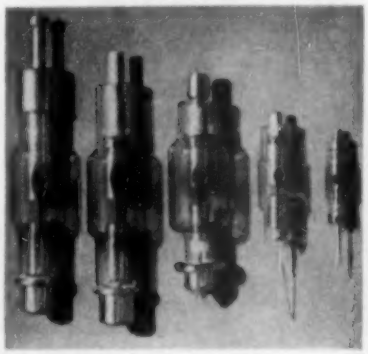


Complete details available by writing to the Sight Feed Generator Co., West Alexandria, Ohio.

Industrial X-ray Tubes

Machlett Laboratories, Inc., Springdale, Conn., announces 5 new industrial X-ray tubes, the PR series, for use in the 120- to 260-pkv range. Designed especially for light-weight, self-contained, portable X-ray tube heads (either oil or



pressurized gas insulated), these new tubes provide compactness, strength and high energy ratings, combined with the extremely useful small focal spot, according to the manufacturer.

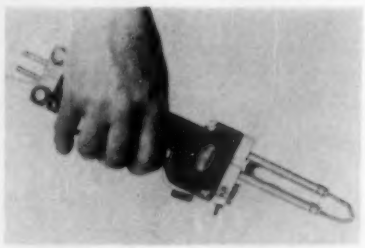
For replacement or for new equipment the PR series X-ray tubes make it possible to select the optimum combination of tube voltage and focal spot size to achieve maximum radiographic quality with minimum exposure time for any of a wide range of field requirements.

For complete details, write directly to the company.

Hand-Held Spot-Welding Head

A new portable, hand-held, spot-welding head for production line welding of small parts and assemblies has been announced by the Equipment Marketing Department of Raytheon Manufacturing Co., Waltham, Mass.

Light in weight and easy to use, the new "Weldpliers" permit rapid, pre-



cision welding in hard-to-get-at locations with a minimum of operator fatigue, according to manufacturer. They are particularly well-suited for welding electronic and electrical components and wiring.

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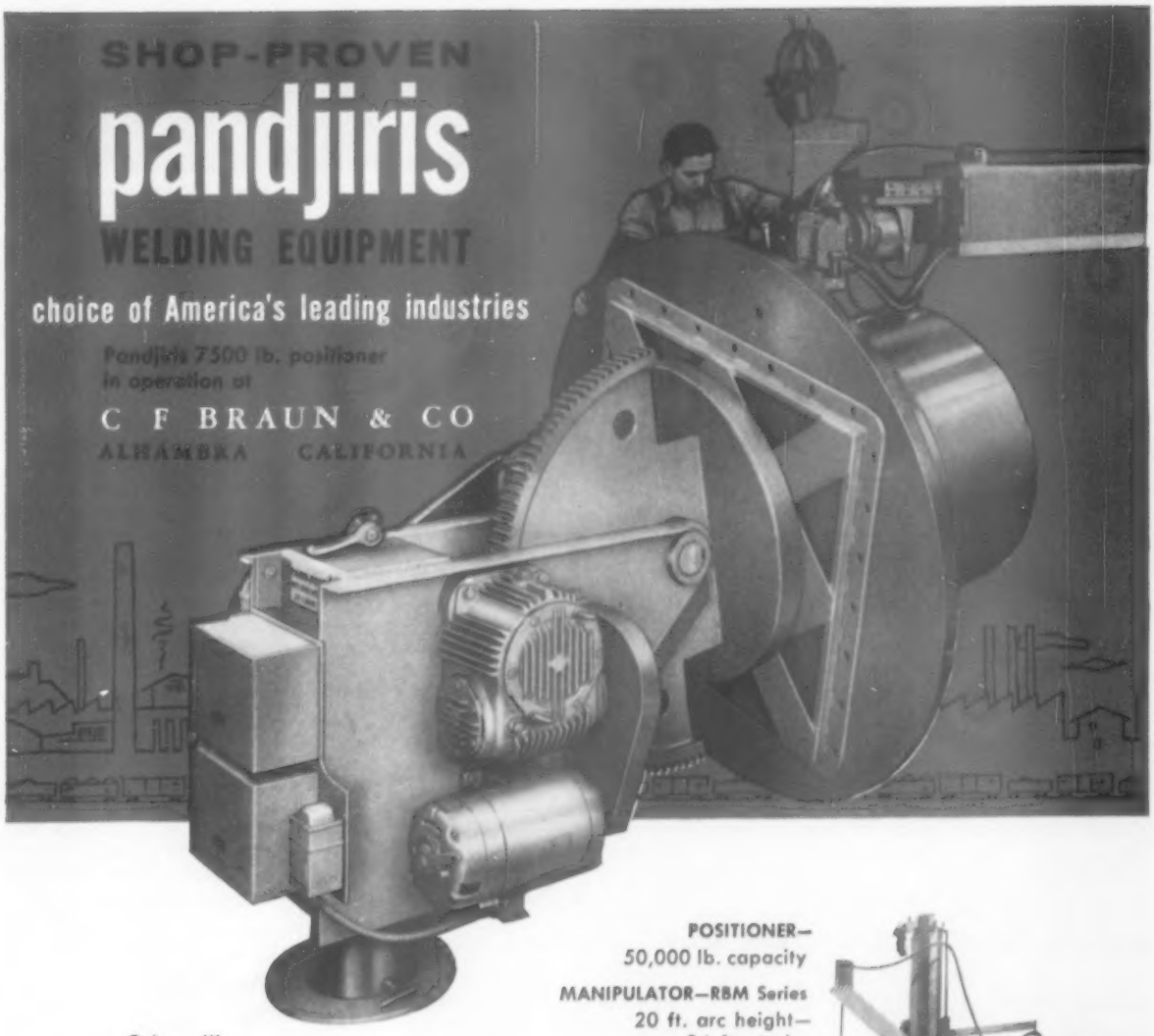

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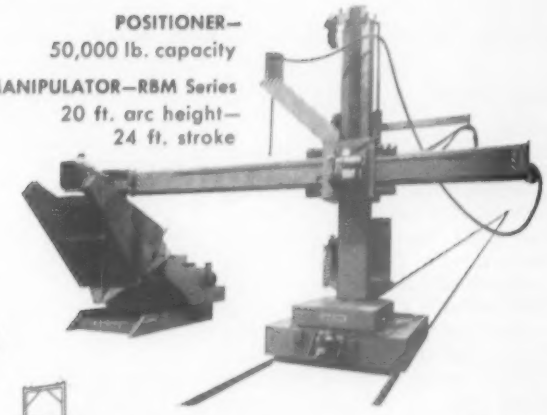

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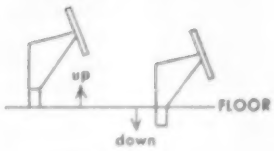

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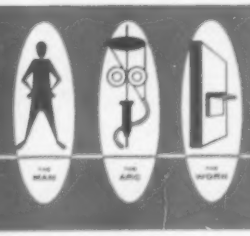

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NEW LITERATURE

Resistance Welding Book Released by American Welding Society

The application of resistance welding has expanded greatly in the last fifteen years. While much technical data has been published to assist in making a more effective use of this process, little consideration has been given to reviewing the published information on the fundamentals of resistance welding.

The latest book released by the American Welding Society, *Resistance Welding—Theory and Use*, has been prepared by the AWS Resistance Welding Committee on the assumption that an understanding of the basic principles is vital to the most effective use of resistance welding. While much of this information has been published previously in one form or another, it is presented in this book in a manner that will be understandable even to someone encountering resistance welding for the first time. At the same time, the book should prove equally useful for more experienced designers, engineers and shop personnel.

This new book covers all the resistance welding processes, and describes the different types of resistance welding machines, electrodes and controls which are used. It discusses the weldability of different metals and how quality control and inspection tests and methods are applied to obtain consistently good welds.

The actual chapter titles are as follows: (1) Definition of Resistance-Welding Terms; (2) Principles of Resistance Welding; (3) Resistance-Welding Processes; (4) Resistance-Welding Equipment; (5) Welding Symbols; (6) Weldability of Metals and Precautions Required; (7) Weld Quality; (8) Procedure Specifications and Qualifications; and (9) Inspection and Testing.

Published by the Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., *Resistance Welding* contains 163 pages and is profusely illustrated. Price is $3.75 for members and $4.50 for nonmembers.

•

Supervisors Safety Manual

A *Supervisors Safety Manual* has been published by the National Safety Council.

Written by staff engineers of the Council's industrial department and carefully reviewed by safety experts from business, industry and government, the manual provides foremen with a comprehensive guide to all phases of industrial safety.

The manual includes material on the human side of safety, maintaining interest in accident prevention, first aid, protective equipment, housekeeping, materials handling, machine guarding, portable power tools and fire prevention.

The *Supervisors Safety Manual* is illustrated with numerous photographs and drawings in its 354 pages. It is available to Council members for $3.25. Nonmember prices are double. For a brochure giving a complete list of the contents and quantity prices, write the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

ASTM Standards on Light Metals

This third edition of *ASTM Standards on Light Metals and Alloys Cast and Wrought*, sponsored by Committee B-7 on Light Metals and Alloys, includes not only those specifications and methods of test which come under the jurisdiction of Committee B-7, but also those for light metal alloy die castings prepared by Committee B-6 on Die Castings, and those for aluminum wire and cable for electrical purposes sponsored by Committee B-1 on Wires for Electrical Conductors. Several methods under the jurisdiction of Committee E-1 on Methods of Testing and Committee E-3 on Chemical Analysis of Metals as well as specifications for aluminum and aluminum alloy arc-welding electrodes and for brazing filler metal under the jurisdiction of the AWS-ASTM Joint Committee on Filler Metal have been included to round out the compilation.

The standards include ingots, castings, bars, rods, wire, forgings, pipe and tube, sheet and plate, wrought products for electrical purposes, filler metal, electroplating and general methods of test. There is also included the ASTM codification system for light metals and alloys.

Copies of this compilation can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa., at $3.50 per copy (276 pages, 6 x 9 in., heavy paper cover).

Welding Products

A new four-page, two-color catalog provides prices and stock sizes of Tisco "Timang" manganese-nickel-steel welding products including rods, hot-rolled plates, special shapes, wedge bars, tooth repointers and applicator bars.

In addition to showing prices and sizes, it contains handy application information pertinent to the products covered.

Copies are available free on request to Taylor-Wharton Division, Harsco Corp., High Bridge, N. J. Please mention Tisco Bulletin 3-56-1M.

Welded Machinery Construction

The British Welding Research Assn. is preparing under the Conditional Aid Scheme, a series of booklets on welding processes, design, inspection and costs.

The booklet, "Arc-Welded Machinery Construction in Mild Steel," deals with the design problem, and in its production emphasis has been laid on providing the facts clearly and concisely.

Details are given concerning the welds used and the static and fatigue stresses imposed upon them, the elements of machines, beams and stiffened flat plates. These are supplemented with diagrams and sketches. Factors which reduce cost and the specification of work for manufacture are dealt with directly and concisely. A comprehensive bibliography of over 50 references is given for further reading and study.

Thirty-six pages of text and illustrations; size 7¼ x 9¾; price 6/- post free.

For your copy, write to Publications Department of the Association, 29 Park Crescent, London, W. I.

Welding Transformers

The Kirkhof Manufacturing Corp. announces the availability of their "Power-Pa'k" Resistance Welding Transformer brochure upon request.

For your copy, write directly to the company at 2450 Buchanan Ave., S. W., Grand Rapids, Mich.

Ampco Welding News

The second-quarter issue of the *Ampco Welding News* was recently released by Ampco Metal, Inc.

The feature article in this issue is entitled, "Corrosion-Resistant Filter Separators Fabricated from Ampco 8" and gives a detailed account of the welding of these units at the Warner Lewis Co. with the inert-gas processes.

Other interesting articles include the fabrication of composite draw dies with Ampco-Trode 300; the rebuilding of a bronze impeller with Phos-Trode; sprocket salvaging with Ampco-Braz No. 1; a résumé of aluminum bronze electrode usage in cement mills, etc.

Free copies of this issue can be secured by writing to Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 46, Wis.

Designer's Guide for Resistance Welding

Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill., introduces Bulletin 331—*Designer's Guide for Electric Resistance Welding*.

This 12-page Sciaky bulletin has as its general objects the over-all design consideration and specific design instruction of resistance welding techniques. Specific fastening methods discussed in detail are spot, seam, projection and flash-butt welding.

For your free copy of *Designer's Guide* in the field of resistance welding, write direct to Department L-9 at the Chicago address.

High-Tensile Structural Steels

During the period of June 1948 to May 1954 the British Welding Research Assn., on behalf of the Ministry of Supply, carried out a considerable research program on the metal-arc welding of high-tensile structural steels. A report on this work, under the title of "The Weldability of High-Tensile Structural Steels," has now been produced and is available, price £1 post free, on application to the Publications Department of the Association, 29 Park Crescent, London, W. I.

The work described in the report includes examination of existing weld-

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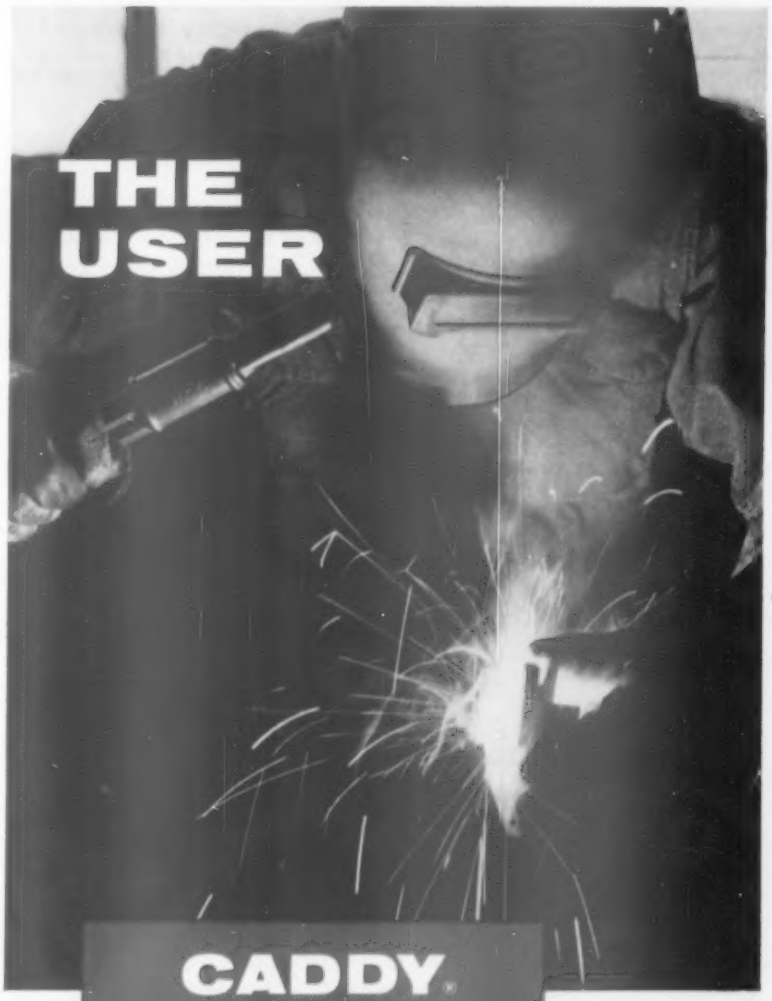

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ability tests, the concept of critical cooling rate and the development of the controlled thermal severity (CTS) test, and the correlation between weldability and end-of-transformation temperature as determined by continuous cooling dilatation tests.

The report is divided into four parts. The first two deal with the development and testing of the special steels and the second two with the mechanism of hard-zone cracking, the assessment of weldability using physical and mechanical testing schedules and the influence of hard-zone cracking on fatigue life of fillet welds.

Welding Directory

The "Lincoln Weldirectory for Stainless Steels, Non-Ferrous Metals, Cast Iron and Manual Hard Surfacing" (SB1352) has recently been released by the Lincoln Electric Co., Cleveland 17, Ohio.

For your copy, please write directly to company.

Hard-Surfacing News

The availability of Vol. 1, No. 6 issue of *Colmonoy Alloy News* is announced by the Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mihc. It features several hard-surfacing applications.

For your copy, apply directly to company at above address.

Brazing Bulletin

Handy & Harman announces the availability of the latest issue, No. 73, of their bulletin *Low Temperature Brazing News.*

Copies may be obtained by writing directly to the company at 82 Fulton St., New York 38, N. Y.

Airborne Kitchen Manufacture

Progress in serving meals aloft, made possible by the development of electrically operated ovens and liquid containers, is the subject of an interesting article in the May-June issue of *Oakite News Service.*

The story, told largely in photographs and text, describes the care taken in selecting and processing stainless steel and aluminum, from cleaning after fabricating operations to the removal of heat discoloration after welding. Of particular importance is the deoxidation of aluminum to provide uniformly low resistance to spot welding.

Copies of this informative magazine are available from Oakite Products, Inc., 118 E. Rector St., New York 6, N. Y.

Electronic Counter Control

Sciaky Bros., Inc., 4915 W. 67th St., Chicago 38, Ill., introduce Bulletin No. 338 which is the first of a group to interpret Sciaky's predetermined, electronic counter welder control. This new medium of Dekatron tube type control which counts cycles of power line frequency to control welder sequence is another notable Sciaky first.

Basically, the bulletin is divided into two sections—development of welder control and the specific features of the Dekatron type welder control.

Bulletin No. 338 may be obtained by writing to the Chicago address, Public Relation Dept. L-10.

Bronze Electrodes Applications Bulletin

Ampco Metal, Inc., has recently printed the latest revision of the four-page Ampco Weldrod applications bulletin, W-25a.

Attractively illustrated, the bulletin describes the characteristics, properties and sizes of the five grades of Ampco-Trode electrodes, both ac and

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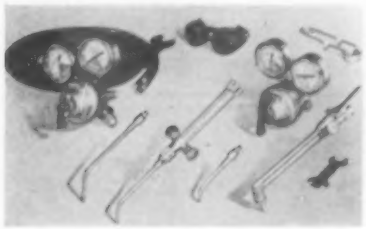
dc; Phos-Trode; Ampco-Trode Filler Rod and Coiled Wire and Ampco-Braz No. 1 and No. 3. Typical applications are listed for each grade of electrode.

This bulletin is intended as a guide in the proper maintenance and repair of metal products serviced by bronze electrodes.

Bulletin W-25a is available at no cost from Ampco Metal, Inc., 1745 S. 38th St., Milwaukee, Wis.

Light-Range Welding and Cutting Outfits

Two new welding and cutting outfits for production welding and limited cutting of light gage metals in aircraft and small parts manufacture, for work on auto bodies, fenders and radiators, and for general sheet-metal work have been developed by Linde Air Products Co., a Division of Union Carbide and Carbon Corp. They have been designated the Purox aircraft welding and cutting outfit and the Purox light welding and cutting outfit. Both include the new, lightweight Purox W-200 welding blowpipe and Purox CW-200 cutting attachment.



The aircraft welding and cutting outfit includes Purox single-stage regulators, while pocket-sized Prest-O-Lite regulators are offered with the light welding and cutting outfit. The larger single-stage regulators are recommended for jobs where the apparatus is in fairly constant use.

Two similar outfits, the Purox aircraft welding outfit and the Purox light welding outfit are available without the cutting attachment for welding operators who have no need for cutting equipment.

Free literature on these outfits is available from Linde Air Products Co., 420 Lexington Avenue, New York 17, N. Y. Ask for Form 50181.

REVIEWS
OF NEW BOOKS

Arc Welding

Industrial Arts Arc Welding, by William A. Sellon, Welding Instructor and Assistant Professor, Department of Industrial Arts, Ohio University, Athens, Ohio. 56 pages, 29 figures. Published by The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio. Price 25¢ per copy, postage prepaid in the U.S.A., 50¢ elsewhere.

This new booklet is not a text or instruction manual, but rather an introduction to the subject for administrators, supervisors, coordinators, teachers trainers, teachers and students.

From his experience in teaching and his contacts with schools, the author tells simply, clearly and concisely why and how arc welding can be taught as a unit in industrial arts. He relates the subject to the objectives of industrial arts teaching and explains how it can be incorporated in different types of shops. The equipment and teacher training needed for these different types are discussed as well as the varying methods of teaching. He also covers separately the subject of safety and provides an excellent bibliography of texts, references, aids and project material.

Table of Contents: The Place of Arc Welding in Industrial Arts; Types of Shops Utilizing Arc Welding; Teacher Preparation for Industrial Arts Arc Welding; Equipment and Supplies for Arc Welding; Teaching Arc Welding; Installing and Maintaining Arc Welding Equipment; Safety Precautions in Arc Welding; What the Arc Welder Can Do for the School; Instructional Material and Aids for Arc Welding.

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INDEX TO ADVERTISERS

Air Reduction ..... 837, 850, Outside back cover
Alloy Rods Co. 849
All-State Welding Alloys Co., Inc. 846
Aluminum Company of America 838, 839
The American Brass Company ..... Inside back cover
American Manganese Steel Div. 847
Arcos Corporation 824, 825
Anti-Borax Compound Co. 855
Aronson Machine Company 830

Bernard Welding Equipment Co. 808

Convair 822

Erico Products 853

Fulton Auto Exchange 848

General Electric 832
General Electric 844, 845

Harris Calorific Co. 813
Haynes Stellite Company, A Division of Union Carbide and Carbon Corp. 835
Hobart Bros. Co. 753

International Nickel Co. 758, 809

The Lincoln Electric Company 833
Linde Air Products Company, A Division of Union Carbide and Carbon Corp. 756

P. R. Mallory & Co., Inc. 755
Metal & Thermit Corporation 831
Miller Electric Manufacturing Co., Inc. 760
Modern Engineering Co. 854

National Carbide Company 843
National Welding Equipment Co. 754

Pandjiris Weldment Co. 851
Progressive Welder Sales Co. 805
Pure Carbonic, Inc. 814, 815

A. O. Smith Corporation 828, 829
Square D Company 821
Stulz-Sickles Co. 840

Tempil° Corporation 856
Thomson Electric Welder Co. 818, 819
Tweco Products, Inc. 841

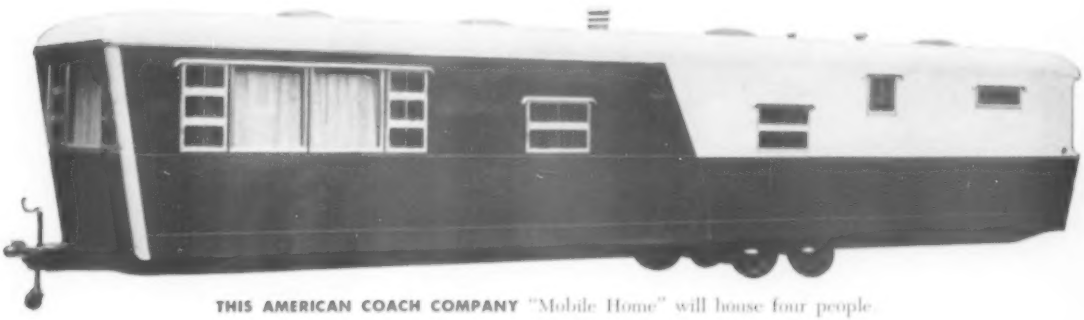
Union Carbide and Carbon Corporation
Haynes Stellite Company 835
Linde Air Products Company 756

Van Vooren Products 848
Vickers Electric Div., Vickers, Inc. 817
Victor Equipment Company ..... Inside front cover

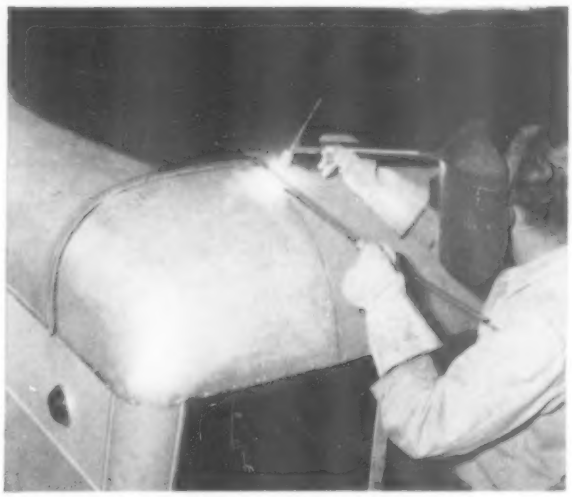
Wagner Mfg. Co. 850
Westinghouse Electric Corp. 834, 855

One operator completes 200 feet of welds a day

Fast Braze Welding with smooth-flowing Everdur*-1010 Welding Rod makes sleek, tight roofs for American Coach Co. "Mobile Homes"



THIS AMERICAN COACH COMPANY "Mobile Home" will house four people.



Braze welding a roof corner on 19-gage zinc-coated steel. One operator welds, grinds and prime-coats 200 linear feet of joints in a day.

Rear wall corner of 24-gage zinc-coated steel, also braze welded. The 22 corner sections needed for a day's production are completed in one hour.

Eleven big "Mobile Homes" a day come off the production lines of American Coach Company, Cassopolis, Michigan, and Newton, Kansas. On the roof of each, four corner segments are braze welded by the inert-gas tungsten-arc method, using filler rod of Everdur-1010, one of Anaconda's well-known copper-silicon alloys. Two rear corner posts are also braze welded in the same way.

"We prefer Everdur rod," says M. E. Wickersham, vice-president in charge of engineering and production for American Coach Company, "because it flows easily and enables our operator to weld rapidly—and because the welds are resistant to corrosion at these critical points. High welding speed means a minimum total heat input and, therefore, the least distortion in the metal and the least effect on the galvanizing."

Besides helping to make smooth and strong roofs, these Everdur braze welds help to keep them waterproof, for Everdur is nonrusting and highly resistant to many types of corrosion.

Everdur-1010 is one of nine Anaconda Welding Rods finding ever-increasing application in production and repair work. Anaconda Welding Rods are available from distributors throughout the United States and Canada. For help in selecting rod, see your distributor or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5611B

*Reg. U. S. Pat. Off.

ANACONDA® **WELDING RODS**

ACCESSORIES FOR GAS WELDING

AIRCO RODS FOR WELDING STEEL

#1 is designed for welding low carbon and low alloy steels including grade A and B pipe.

#4 is a low priced, general purpose, high tensile steel rod.

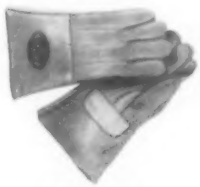
#7 mild steel rod is used for every day welding of sheets, plates, etc.

AIRCO GOGGLES

Cover goggles protect eyeglasses and shut out glare. Fit over any type of eyeglasses.

Welding and cutting goggles give excellent ventilation without light filtration.

Airco replacement lenses available in all densities to fit your frames.



AIRCO GLOVES

Tough #1 Carpincho leather . . . suitable for gas or arc welding. Other glove types available include horsehide and asbestos models.

AIRCO WELD-CLEANING TOOLS

Atlas Model A Dual Tool consists of a combined chipping hammer with chisel head and detachable wire bristle brush.

AIRCO SPARKLIGHTER

For instant lighting of gases. A hood directs sparks. Round renewal flint tips are replaceable.

AIRCO-TWIN HOSE

Two neoprene lined, rayon cord reinforced hoses molded into a single unit . . . doesn't kink.

With or without connections. Meets I.A.A. specifications.

AIRCO CYLINDER TRUCK

Two-wheel hand truck assures good balance. Semi-pneumatic tires. Strong, rigid, welded steel frame. Other large-wheeled models for soft, uneven or rough surface conditions.

ATLAS CAST IRON WELDING FLUX

Floats out oxides and impurities to assure sound cast iron weld metal. Apply by dipping heated end of filler rod into the flux.

MARVEL BRAZE WELDING FLUX

The general purpose flux . . . remains molten and viscous over a wide temperature range. For conventional welding and braze welding of cast iron, malleable iron, steel, copper, brass and bronze.

HI-TEST BRAZE WELDING FLUX

For braze welding with brass rods on steel, malleable iron or other metals. Provided in paste form to permit uniform application to both work and rod.

AIRCOSIL SILVER BRAZING FLUX

Entirely fluid at 1100°F and remains fluid and active over a wide temperature range. Use with AIRCOSIL alloys when silver brazing stainless steel, nickel, monel copper, brass and other ferrous and non-ferrous alloys.

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